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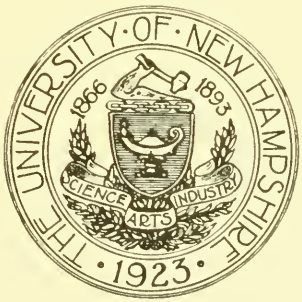
NEW HAMPSHIRE

AGRICULTURAL EXPERIMENT STATION

ELECTRICITY ON NEW ENGLAND FARMS

A REPORT OF THE NEW HAMPSHIRE PROJECT ON THE RELATION OF ELECTRICITY TO AGRICULTURE FOR THE YEARS 1925-1926



By W. T. ACKERMAN

THE UNIVERSITY OF NEW HAMPSHIRE

DURHAM, N. H.

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ELECTRICITY ON NEW ENGLAND FARMS*

The 160,000 farms in New England according to estimates by the United States Department of Agriculture require more than 1,000,000 horse power to carry on operations. This is an average of 6.7 horse power per farm and includes only the power of work animals, gas engines, steam engines, electric, wind and water motors. If statistics for the country as a whole may be taken, approximately one third of this amount is used in stationary farm operations, for which electricity as generated and distributed by electric companies is a possible source of power. The figure does not include household equipment, lighting and human labor necessary to perform many farm and home tasks in which electric current might conceivably be utilized.

In view of the rapid expansion of electric power throughout the country the questions arise: What percent of the human, animal and machine labor involved on these farms may be profitably performed with electricity as energy? How much of an electric load can be built up on representative New England farms? What appliances can be economically used on such farms? And will the resulting use of electricity be sufficient to pay power companies an adequate return on lines extended into the rural sections? In order to answer such questions experimental work was started in 1925 on seven representative farms in different sections of New Hampshire with a view to collecting data which would be applicable to New England in general.

These farms, comprising dairy, fruit, poultry and general purpose farms were selected and equipped with appliances to determine what limits in quantity of electricity can be economically and efficiently used in their operations.

The equipment installed is metered in such a way that detailed records can be secured each month for each piece of equipment. In some cases comparative tests with other forms of power are made. Sixty major and 40 minor pieces of equipment are now in use on the farms covering 36 or more distinct operations and involving 50 or more different makes. Two of the farms were previously well equipped and have, therefore, furnished 16 months' records. In the remaining cases the period covered by the records to date varies from three to nine months.

The farms comprising the experimental group were selected with considerable care with particular emphasis on the number of operations that could be experimented with and the intention of the farmer to exert himself in furnishing accurate and full information. These farms cannot be classed as average farms of New England. They are considerably above the average in productiveness, man-power and industry. For reasons that need not be enlarged upon here, it was necessary to select such a type to provide opportunities for testing out a greater variety of operations. On the other hand, none is in the nature of a "gentleman's estate" or endowed with an undue amount of capital or wealth. They are typical of the substantial and successful farm operated with modern, well-balanced methods.

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*This is a progress report of the New Hampshire experiment on rural electrification for the New England territory carried on by the University of New Hampshire Experiment Station in cooperation with the National and State Committees on the Relation of Electricity to Agriculture for the two year period ending December 31, 1926. Future reports, covering groups of appliances and their operating characteristics in greater detail and for a longer period of time, are planned.

Appreciation is here expressed to the manufacturers of equipment, cooperating farmers, agricultural organizations, electrical interests and others who have generously given of their support, financial and otherwise, which has made this work possible. Cooperating farmers are: D. T. Atwood, Franklin; R. T. Gould, Contoocook; J. R. Graham, Boscawen; R. E. Holmes, Stratham; S. D. Sterling, Dover; N. F. Stearns, West Lebanon; and G. E. Townsend, Salem.

The territory covered by the experimental group now extends from the southeastern side of the state at Salem, north to Dover, west to Concord, Penacook and Franklin, and then to Lebanon on the western boundary of the state, about midway in a north and south direction.

The cooperators are not obligated to keep all of the equipment tried out on their farms. It is estimated that at least 80% of the household equipment installed at present on the experimental farms will be permanently retained, though just what percent of the farmstead equipment will be kept is less evident, due to the experimental nature of much of it. Later reports will be issued, giving in more detail the cost of operating each appliance separately and in groups, amount of use made of them, character of service rendered and returns on the investment.

For the present, inventories with cost figures and partial deductions for various appliances are given herewith for each farm.

Few figures are available for comparing the investment between the usual standard and electrical equipment for the farm; and so far as farm home equipment is concerned there are even fewer figures.

The 1925 census gives $420.00 as the average investment in implements and machinery on New Hampshire farms, but this classification probably covers very little of the type of equipment being used in the project, and, of course, includes a great many small and run-down farms.

From figures on investment in farmstead and field machinery, other than electrically operated, on file at the University, it is estimated that the larger, more active, farms in New Hampshire, have approximately $2,000.00, more or less, invested, and that medium-sized farms, in the active class, would have $750.00 to $1500.00 invested in such equipment. These figures are not likely to include such fixed equipment as water supply systems, dairy cooling rooms and other built-in equipment which would be considered as a part of the real estate.

Some electrically operated equipment is very efficient and has such a close relation to the labor problem that its practical value would be arrived at by a different analysis than a mere comparison of inventories. For example: the soundness of an investment of $750.00 to $800.00 in a dairy cooling room would have been immediately questioned a few years ago. Results thus far obtained in the experiment indicate promising possibilities of this equipment paying for itself on retail dairy farms in less than five years and then paying a dividend for several years if well built and sturdy equipment is used. Probably a greater number of factors enter into the arrival at this conclusion than with the older types of equipment being considered.

On the other hand, another type of equipment of nominal cost may meet with quick disapproval because of one of these same factors. This, then, is not an attempt to justify large investments in equipment, but rather to point out the necessity of measuring the practical value of electrically operated devices by a somewhat different standard.

It will also serve to explain what may at first appear to be large investments in equipment on the experimental farms.

Material Contained in Tables. The tables of current consumption for each farm are based on monthly readings by circuits or similar divisions. These are substantiated by company readings against whose records the monthly costs were also checked. Individual test meters, placed on each appliance, furnish more detailed information..

The reader's attention is particularly directed to the section of each table printed in bold-face type, following the tabulation by months, which summarizes such important facts as monthly average, daily average for the year, percent of the total consumption used by each circuit, the average rate per kilowatt hour for each of the three circuits and the combined average rate of all circuits for the year.

Current consumption on farmstead equipment on practically all of the farms did not reach a well established limit during the past year due to the experimental nature of many of the operations, but can be expected to increase as successful applications are completed.

FARM NO. 1 (RETAIL DAIRY)

DESCRIPTION

Four-man farm. Family of 4 adults, 2 children. Ten room brick house. Large dairy barn with silos attached, large implement shed containing ice house; other out-buildings. 175 acres of river bottom land, level and free of stone. 45 head of cattle, 36 milked, 3 horses, 2 tractors, 1 Ford delivery truck, pleasure car, modern machinery. Farm retails 300 quarts of milk and cream a day in village two miles distant. House and barns wired about seven years with no line construction cost. Two transformers of 10 K.V.A. capacity used in parallel to balance load. A new rate schedule with one master meter permits use of any appliance properly wired and fused.

EQUIPMENT COSTS

The following inventory gives each item of electrical equipment in use, with its original purchase price and cost of installation, if any. New equipment is shown in Italics with date of installation in parentheses.

Household Equipment.

1.	Wiring of house and barns including fixtures	$325.00
2.	Wiring of tenant house	75.00
3.	Flat Iron	8.50
4.	Fireless Cooker	37.00
5.	*Percolator* $9.50; (6) Curling Iron $4.00 (March, 1926)	13.50
7.	*Washing Machine* (Dec., 1925)	155.00
8.	*Vacuum Cleaner* (April, 1926)	39.50
9.	*Household Refrigerator*	250.00
	Installation Labor and Material (Aug., 1926)	24.09
10.	*Kitchen Range*	225.00
	Installation Labor and Material (Dec., 1925)	87.00
11.	*Hot Water Heater*	132.50
	Installation Labor and Material (June, 1926)	33.40
12.	*Sewing Machine Motor* (Aug., 1926)	18.50
	Group Total	$1423.99

Farmstead Equipment.

13.	Milking Machine Motor (*not metered until July*, 1925)	$100.00
	Installation Labor and Material	17.40
14.	Cream Separator—Motor Equipment	35.00
15.	*7½ H. P. Portable Utility Motor*	325.00
	Installation Costs (July, 1926)	12.10
16.	*Water Pump—Owner's House*	87.20
	Tank 48x72	138.00
	Installation Incidentals (Dec., 1925)	7.00
17.	*Water Pump—Tenant House* (June, 1926)	125.00
18.	*Hay Hoist* (July, 1925)	130.00
19.	*1½ H. P. Shop Motor* (not connected)	82.80
20.	Yard and Building Flood Light (not connected)	29.70
21.	*Concrete and Fertilizer Mixer* (tested only)	57.00
22.	*Dairy Cooling Room* (April, 1926)	
	Mechanical Equipment—Installed price	510.80
	Room Construction and Insulation (*Material and Labor*)	194.45
	Group Total	$1851.45
	All equipment total	$3275.44

DISTRIBUTION OF EQUIPMENT COSTS

	Lighting	*Heating*	*Power*	*Household*	*Farmstead*
Per cent of appliances	45.4	27.3	27.3	54.5	45.5
Per cent of total cost	24.9	45.9	29.2	43.4	56.6
Per cent of circuit cost for appliances	84.1	90.4	96.2		
Per cent of circuit cost for installation	15.9	9.6	3.8		

Of the total equipment cost 89.6% is for appliances and 10.4% for installation.

Farm No. 1. Current Consumption and Costs—1925-1926. Table 1 shows current consumed on Farm No. 1 for 1925 and 1926.

Equipment operated during 1925 consisted of Items 1-7, 13, 14 and 16 as given on the preceding page.

The rate schedule was changed Jan., 1926, and for the second year all equipment was on one master meter. Equipment operated in 1926 included the entire list *"Equipment Costs"* except the flood light and shop motor.

It will be noted that the average daily consumption on the light circuit did not reach 2 kilowatts during any season of 1925. Practically no variation occurred, which is unusual.

TABLE 1. Current Consumption and Costs for 1925 and 1926—Farm No. 1

	Light Circuit		Power Circuit		Monthly Total All Circuits		Daily Average All Circuits	
	Kilowatt Hours	Cost	Kilowatt Hours	Cost	Kilowatt Hours	Cost	Kilowatt Hours	Cost
1925								
January	67	$8.04	49	$3.76	116	$11.80	3.74	$0.383
February	45	5.40	49	3.76	94	9.16	3.35	.327
March	43	5.16	32	3.04	75	8.20	2.41	.264
April	38	4.56	34	3.13	72	7.69	2.40	.256
May	29	3.48	38	3.30	67	6.78	2.16	.218
June	29	3.48	27	2.83	56	6.31	1.86	.210
July	36	4.32	63	4.36	99	8.68	3.19	.280
August	43	5.16	160	8.48	203	13.64	6.54	.440
September	40	4.80	155	8.27	195	13.07	6.50	.435
October	55	6.60	162	8.57	217	15.17	7.00	.489
November	56	6.72	145	7.84	201	14.56	6.70	.485
December	51	6.12	226	11.29	277	17.41	8.93	.564
Year's total	532	$63.84	1140	$68.63	1672	$132.47	....	....
Monthly average	44.3	5.32	95.0	5.71	139.3	11.03	....	....
Daily average	1.45	.17	3.12	.18	....	....	4.57	$0.36
Per cent	31.82%	48.19%	68.18%	51.81%	100%	....	....	....
Average rate per kwh.	....	$0.12	....	$0.0602	....	$.0792	....	....
Seasonal Daily Averages								
Jan., Feb., Mar.	1.72	$0.206	1.15	$0.117	....	....	3.16	$0.323
Apr., May, June	1.05	.126	1.08	.101	....	....	2.13	.227
July, Aug., Sept.	1.29	.155	4.10	.229	....	....	4.31	.384
Oct., Nov., Dec.	1.77	.211	5.79	.301	....	....	7.56	.512
1926								
January	....	....	....	....	334	$16.88	10.77	$0.541
February	....	....	....	....	430	20.72	15.35	.740
March	....	....	....	....	420	20.32	13.54	.655
April	....	....	....	....	460	21.92	15.33	.730
May	....	....	....	....	550	25.52	17.74	.823
June	....	....	....	....	590	27.12	19.66	.901
July	....	....	....	....	910	39.92	29.35	1.28
August	....	....	....	....	870	38.32	27.41	1.23
September	....	....	....	....	900	39.52	30.00	1.31
October	....	....	....	....	810	35.92	26.12	1.15
November	....	....	....	....	690	31.12	23.00	1.02
December	....	....	....	....	730	32.72	23.54	1.05
Year's total	....	....	....	....	7694	$350.00	....	....
Monthly average	....	....	....	....	641.1	29.16	....	....
Daily average	....	....	....	....	....	....	21.07	$0.958
Average rate per kwh.	....	....	....	....	....	$.0455	....	....
Seasonal Daily Averages								
Jan., Feb., Mar.	....	....	....	....	....	....	13.22	$0.643
Apr., May, June	....	....	....	....	....	....	17.5	.817
July, Aug., Sept.	....	....	....	....	....	....	28.9	1.29
Oct., Nov., Dec.	....	....	....	....	....	....	24.23	1.07

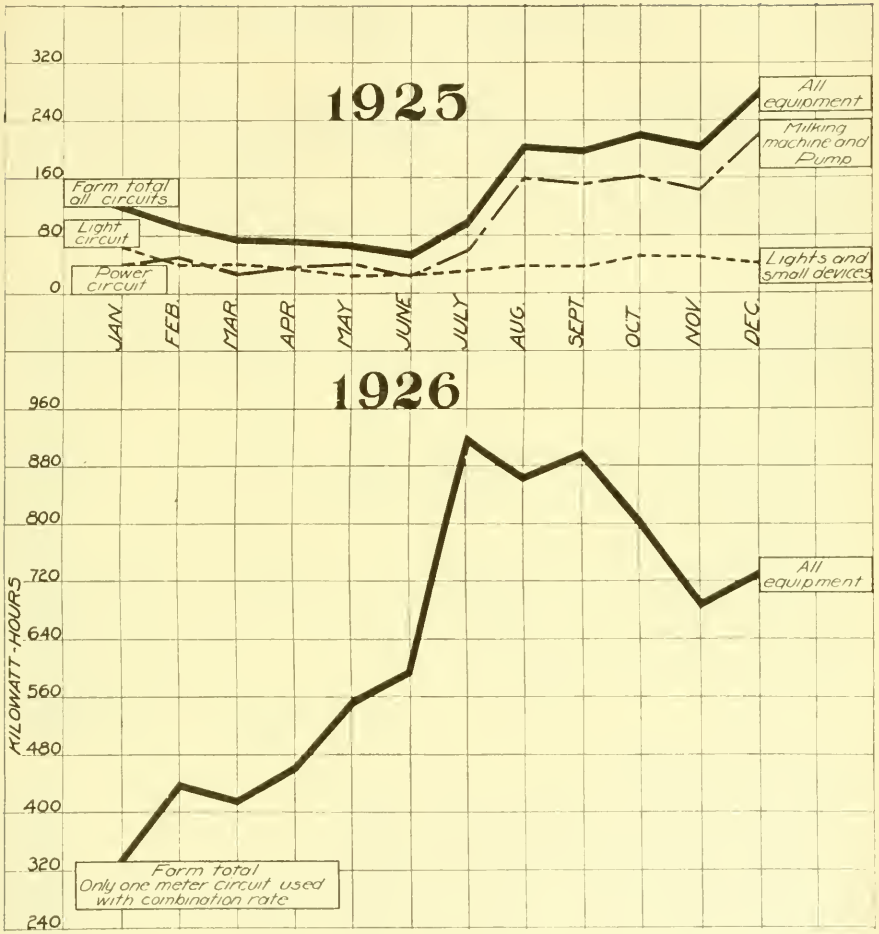

FIG. 1. Electric load, 1925 and 1926, on Farm No. 1.

In 1926 the increase in electric load or consumption for the farm as a whole amounts to 360%.

The 1925 load curve in Fig. 1 shows the results for a year before efforts at load building were started, and may be considered as normal consumption up to this time. The lighting circuit curve is unusually flat, showing a fairly uniform consumption throughout the year. In the power circuit curve the increase in November and December is not normal and was caused by the installation of the electric range. If this appliance had not been installed there would have been a pronounced decline starting with October. The two slight peaks at August and October are normal.

The 1926 curve shows the result of active efforts at load building which increased the consumption 360% over the original load and placed well defined peaks from July to September. Considering that most city load curves show quite a depression during the summer season, this trend is probably desirable from the power company's standpoint.

FARM NO. 2 (RETAIL DAIRY)

DESCRIPTION

Three to four-man farm. Family of three adults. Nine room house. Large dairy barn with silo attached; two garages and implement shed. 75 acres of which 30 acres are tillable. 36 head of milking cattle, 2 horses, 1 tractor, 1 delivery truck, pleasure car, modern machinery. Farm located on state road. Retails 250 to 300 quarts of milk and cream daily in city one mile distant. House and barns wired 10 years under cooperative arrangement between farmers and service company; 12 pole extension; cost $375. One transformer of 3 K.V.A. capacity.

EQUIPMENT COSTS

Much of the following equipment has been installed by the men of the place themselves, and this may account for some variation from the usual cost prices. (The rate for current in this location practically prohibits the use of high-wattage heating devices).

Light Circuit Equipment

1.	Wiring of house and barns, including fixtures	$450.00
2.	House lights—25 outlets, average 40 Watt lamps	10.00
3.	Barn lights—22 outlets, average 40 Watt lamps	8.80
4.	Flat iron	6.50
5.	Washing Machine	150.00
6.	Bottle Brush (No installation cost)	40.00
7.	Shop equipment (No installation cost)	25.00
8.	Vacuum Cleaner	60.00
9.	Special vacuum pump for milking machine	150.00
10.	5 H. P. motor for milking machine	80.00
11.	*Battery charger* (Jan., 1926)	19.50
	Group Total	$999.80

Power Circuit Equipment

12.	House Refrigeration machine (Rental contract)	
	Initial deposit	$225.00
	Rental charge ($2.00 per month) 34 months	68.00
13.	Dairy Cooling Room Machine (Rental contract)	
	Initial deposit	225.00
	Rental charge ($2.00 per month) 34 months	68.00
	Insulation of cooling room (converted ice room)	13.00
14.	Milk Cooling Pump (No installation cost)	76.00
	Group Total	$675.00
	All equipment total	$1674.80

DISTRIBUTION OF EQUIPMENT COSTS

	Light and Power Circuit	*Heat Circuit*	*Household*	*Farmstead*
Per cent of total appliances	78.6	21.4	42.9	57.1
Per cent of total equip. cost	59.6	40.4	51.1	48.9

Farm No. 2—Current Consumption and Costs. Table 2 shows the current consumed on Farm No. 2 for 1925 and 1926.

The full list of equipment given on the preceding page was operating for the two-year period.

The total consumption for 1925 was 3362 kilowatt hours and for 1926 was 3252 kilowatt hours.

The total of both circuits in 1925 shows a steady rise from 5.21 kwhs. per day in the winter season to 12.58 kwhs. in the summer and then a decline to 8.43 kwhs. in the fall. Practically the same tendencies are evident in 1926, although the values are somewhat lower, due to more efficient operation and improvement of equipment.

TABLE 2. Current Consumption and Costs for 1925 and 1926—Farm No. 2

	Heat Circuit		Light and Power Circuit		Monthly Total All Circuits		Daily Average All Circuits	
	Kilowatt Hours	Cost	Kilowatt Hours	Cost	Kilowatt Hours	Cost	Kilowatt Hours	Cost
1925								
January	....	....	183	$23.79	183	$23.79	5.90	$0.767
February	9	$0.63	136	17.68	145	18.31	5.17	.654
March	36	2.52	105	13.65	141	16.17	4.54	.521
April	112	7.84	153	19.89	265	27.73	8.50	.924
May	157	10.99	115	14.95	272	25.94	8.77	.837
June	274	19.18	149	19.37	423	38.55	14.10	1.282
July	250	17.50	108	14.04	358	31.54	11.54	1.015
August	252	17.64	111	14.43	363	32.07	11.70	1.032
September	264	18.48	173	22.49	437	40.97	14.56	1.365
October	139	9.73	147	19.11	286	28.84	9.22	.931
November	120	8.40	156	20.28	276	28.68	9.20	.956
December	9	.63	204	26.52	213	27.15	6.87	.876
Year's total	1622	$113.54	1740	$226.20	3362	$339.74	....	....
Monthly average	135.1	9.44	145.0	18.41	280.1	27.85	....	....
Daily average	4.45	.312	4.76	.618	....	....	9.21	$0.930
Per cent	48.21%	33.4%	51.79%	66.6%	100%	....	....	....
Average rate per kwh.	....	$0.07	....	$0.13	....	$0.101	....	....
Seasonal Daily Averages								
Jan., Feb., Mar.	.5	$0.035	4.71	$0.612	....	....	5.21	$0.647
Apr., May, June	5.96	.417	4.59	.596	....	....	10.55	1.01
July, Aug., Sept.	8.32	.582	4.26	.553	....	....	12.58	1.13
Oct., Nov. Dec.	2.91	.203	5.51	.716	....	....	8.42	.919
1926								
January	5	$0.35	193	$25.09	198	$25.44	6.38	$0.820
February	4	.28	117	15.21	121	15.49	4.32	.553
March	5	.35	161	20.93	166	21.28	5.35	.686
April	59	4.13	157	20.41	216	24.54	7.20	.818
May	152	10.64	170	22.10	322	32.74	10.38	1.056
June	229	16.03	125	16.25	354	32.28	11.80	1.076
July	205	14.35	117	15.21	322	29.56	10.38	.953
August	226	15.82	146	18.98	372	34.80	12.00	1.122
September	209	14.63	175	22.75	384	37.38	12.80	1.246
October	165	11.55	118	15.34	283	26.89	9.12	.867
November	96	6.72	166	21.58	262	28.30	8.73	.943
December	19	1.33	233	30.29	252	31.62	8.12	1.020
Year's total	1374	$96.18	1878	$244.14	3252	$340.32	....	....
Monthly average	114.5	.802	156.5	2.035	271	2.837	....	....
Daily average	3.77	.264	5.14	.668	8.91	.932	....	....
Per cent	42.2%	28.3%	57.8%	71.7%	100%	....	....	....
Average rate per kwh.	....	$0.07	....	$0.13	....	$0.104	....	....
Seasonal Daily Averages								
Jan., Feb., Mar.	.155	$0.011	5.23	$0.680	....	....	5.39	$0.691
Apr., May, June	4.83	.338	4.96	.646	....	....	9.79	.984
July, Aug., Sept.	6.96	.486	4.76	.618	....	....	11.72	1.10
Oct., Nov., Dec.	3.04	.213	5.61	.741	....	....	8.65	.954

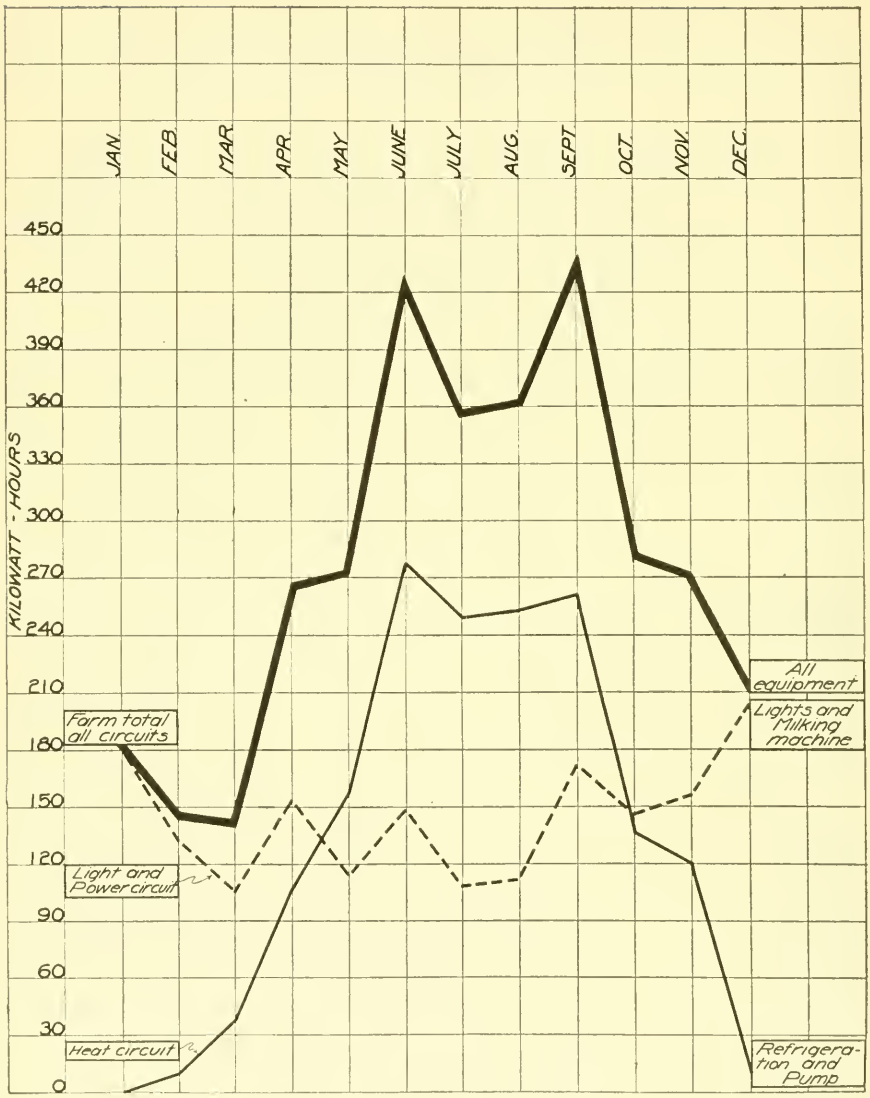

FIG. 2. Electric load for 1925 on Farm No. 2.

FARM TOTAL AND SUMMARY

The curves of total consumption for Farm No. 2, as shown in Figs. 2 and 3, are very similar in general contour, and show a well established plan in the use of the electrical equipment used throughout both years. The high peak load comes from June to September each year with the extreme values on these two months. A slight falling off between these peaks occurs in both years in both circuits.

Here again is a farm load that appears to have desirable qualities from the standpoint of the power utility company.

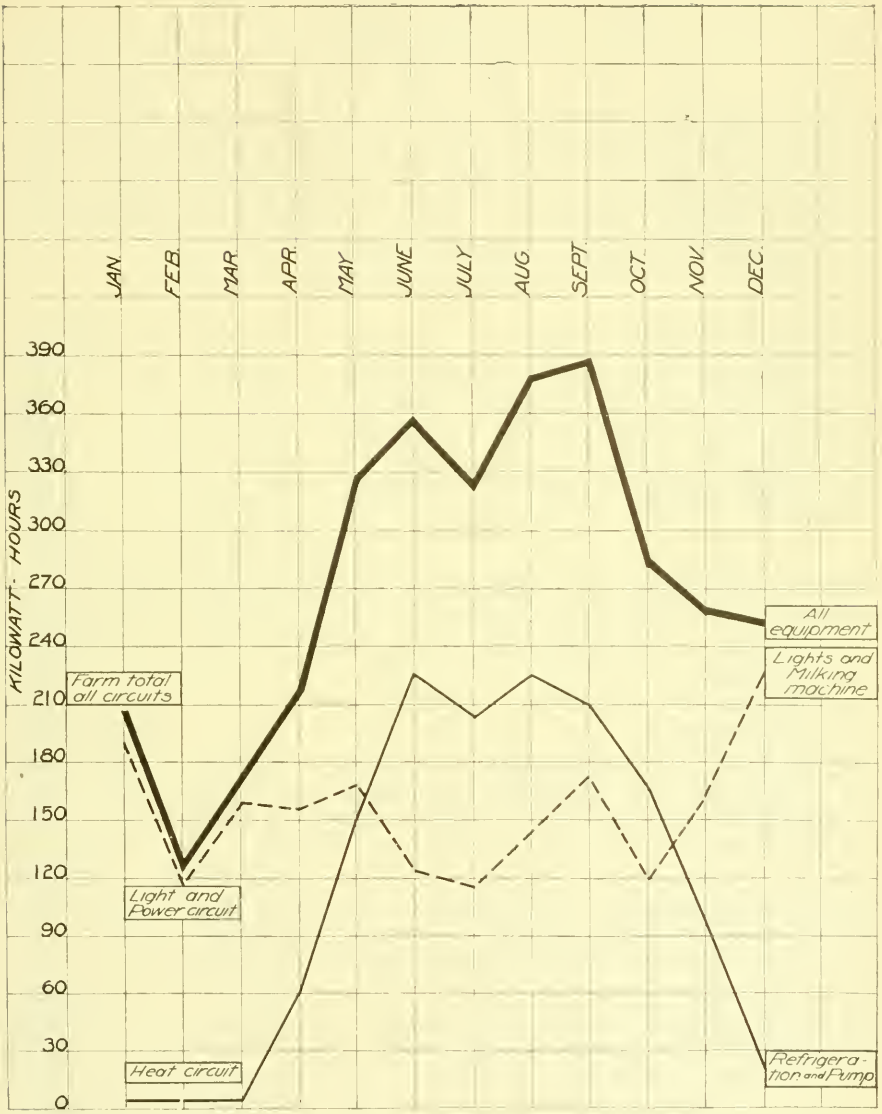

FIG. 3. Electric load for 1926 on Farm No. 2.

The decline from January to March in 1925 on the light and power circuit is one month longer in duration than in 1926. A late spring might easily have caused this. The milking machine is on this circuit with the lights and small devices. Refrigeration is the principal load on the heat circuit. It will be noticed that the peak loads in 1926 do not run as high as in 1925. While this may be partly due to cooler seasonal temperatures, a more important factor was the improvement of the insulation of the dairy cooling room. Many leaks and points requiring extra insulation were found and repaired in the winter of 1925-26.

FARM NO. 3 (WHOLESALE DAIRY)

DESCRIPTION

Three-man farm. Family of three adults, two children. Fourteen room house. Large dairy barn with silo, horse barn, garage and shop, medium sized ice house, granary, implement shed, and medium sized hay barn. Hill farm of 330 acres of which 75 are tillable. 47 head of cattle, 27 milked, 3 horses, one tractor, one delivery truck, pleasure car, modern machinery. Farm delivers an average milking in morning and night of 225 to 250 quarts of milk and cream per day to retailers in town three miles distant. House and buildings wired in 1903 from nearby line without construction cost. Transformers used,—light and heat circuit 7.5 K.V.A., power circuit 2.5 K.V.A.

EQUIPMENT COSTS

Light Circuit Equipment.

1.	Wiring of house and barns, including fixtures Armored conduit, concealed wiring system.	$315.00
2.	House lights—55 outlets, average 40 watt lamps	22.00
3.	Barn lights—20 outlets, average 40 watt lamps	8.00
4.	House water pump	75.00
	Installation cost—electric and plumbing	15.00
5.	Vacuum cleaner	52.00
6.	Curling iron $3.50; (7) Radiant Heater $7.00	10.50
	Group Total	$497.50

Heat Circuit Equipment. (Installation of the heating circuit wiring is included in the following installation costs.)

8.	Combination wood-electric range	$321.50
	Installation costs—electric and plumbing	92.00
9.	Dishwasher	80.00
	Installation costs	0.00
10.	Clothes Washer	150.00
	Installation costs	0.00
11.	*Hot water heater* (July, 1926)	64.50
	Installation costs—electric and plumbing	27.67
12.	Waffle Iron $12.00; (6) Toaster $5.00; (7) Percolator $8.50	25.50
13.	Flat iron	5.00
	Group Total	$766.17

Power Circuit Equipment. (Installation of the power circuit wiring is included in the following installation costs).

14.	2 H. P. motor—operating the milking machine, cream separator and milk cooling pump	$ 75.00
	Installation cost	35.00
15.	Centrifugal water pump for milk cooling	30.00
16.	Shafting, pulleys, hangers, belts, etc., for the above	25.00
	Installation costs	15.00
	Group Total	$180.00
	All equipment total	$1443.67

DISTRIBUTION OF COST EQUIPMENT

	Lighting	*Heating*	*Power*	*Household*	*Farmstead*
Per cent of appliances	38.9	44.4	16.7	83.25	16.75
Per cent of total cost	34.5	53.1	12.4	87.5	12.5
Per cent of circuit cost for appliances	75	84	72.7		
Per cent of circuit cost for installation	25	16	27.7		

Of the total equipment cost 77.2% is for appliances and 22.8% for installation.

Farm No. 3—Current Consumption and Costs. Table 3 shows the current consumed by Farm No. 3. Except for the hot water heater which was installed during the summer of 1926, the full equipment listed under "Equipment Costs", was operating for the two-year period.

TABLE 3. Current Consumption and Costs for 1925 and 1926—Farm No. 3

	LIGHT CIRCUIT		HEAT CIRCUIT		POWER CIRCUIT		MONTHLY TOTAL ALL CIRCUITS		DAILY AVERAGE ALL CIRCUITS	
	Kilowatt Hours	Cost	Kilowatt Hours	Cost	Kilowatt Hours	Cost	Kilowatt Hours	Cost	Kilowatt Hours	Cost
1925										
January	77	$6.76	18	$1.00	123	$9.38	218	$17.14	7.03	$0.553
February	63	5.64	14	1.00	102	8.12	179	14.76	6.39	.527
March	42	3.96	120	4.50	97	7.76	259	16.22	8.35	.523
April	31	3.08	15	1.00	86	6.88	132	10.96	4.40	.365
May	37	3.56	21	1.04	115	8.90	173	13.50	5.58	.435
June	17	1.90	49	2.02	96	7.68	162	11.60	5.40	.386
July	18	2.00	39	1.67	99	7.92	156	11.59	5.03	.374
August	24	2.52	49	2.02	98	7.84	171	12.38	5.51	.399
September	41	3.88	43	1.81	113	8.78	197	14.47	6.56	.482
October	50	4.60	32	1.42	113	8.78	195	14.80	6.29	.477
November	78	6.84	28	1.28	116	8.96	222	17.08	7.40	.569
December	97	8.36	16	1.00	156	11.36	269	20.72	8.67	.668
Year's total	575	$53.10	444	$19.76	1314	$102.36	2332	$175.22	....	....
Monthly average	47.9	4.42	37	1.65	109.5	8.53	194.3	14.60	....	....
Daily average	1.57	.146	1.22	.054	3.6	.28	....	....	6.38	$0.48
Per cent	24.65%	30.33%	19.02%	11.29%	56.34%	58.38%	100%		....	....
Average rate per kwh.	....	$0.0923	....	$0.0445	....	$0.0778	....	$0.0715	....	....
Seasonal Daily Averages										
Jan., Feb., Mar.	2.02	$0.181	1.68	$0.072	3.57	$0.280	....	....	7.27	$0.534
Apr., May, June	.934	.094	.934	.045	3.26	.258	....	....	5.13	.396
July, Aug., Sept.	.902	.091	1.42	.059	3.37	.267	....	....	5.71	.418
Oct., Nov., Dec.	2.44	.215	.826	.040	4.18	.316	....	....	7.45	.572
1926										
January	73	$6.50	14	$1.00	146	$10.76	233	$18.26	7.51	$0.589
February	59	5.26	9	1.00	121	9.26	189	15.52	6.75	.554
March	77	6.76	22	1.07	193	13.58	292	21.41	9.41	.690
April	38	3.64	17	1.00	146	10.76	201	15.40	6.70	.513
May	51	4.68	20	1.00	215	14.60	286	20.28	9.22	.654
June	24	2.52	28	1.28	133	9.98	185	13.78	6.16	.459
July	20	2.20	80	3.10	109	8.54	209	13.84	6.74	.446
August	25	2.60	112	4.22	119	9.14	256	15.96	8.25	.514
September	39	3.72	38	1.63	143	10.58	220	15.93	7.33	.531
October	41	3.88	39	1.67	115	8.90	195	14.45	6.29	.466
November	70	6.20	11	1.00	138	10.08	219	17.28	7.30	.576
December	77	6.76	14	1.00	194	13.64	285	21.40	9.19	.690
Year's total	594	$54.72	404	$18.97	1772	$129.82	2770	$203.51	....	....
Monthly average	49.5	4.56	33.6	1.58	147.6	10.81	230.8	16.96	....	....
Daily average	1.62	.149	1.11	.0519	4.85	.355	....	....	7.58	$0.556
Per cent	21.44%	26.89%	14.59%	9.32%	63.97%	63.79%	100%	....	....	....
Average rate per kwh.	....	$0.092	....	$0.0469	....	$0.0732	....	$0.0707	....	....
Seasonal Daily Averages										
Jan., Feb., Mar.	2.32	$0.205	.5	$0.034	5.11	$0.373	....	....	7.93	$0.612
Apr., May, June	1.24	.119	.714	.036	5.42	.388	....	....	7.37	.543
July, Aug., Sept.	.913	.093	2.5	.097	4.03	.307	....	....	7.44	.496
Oct., Nov., Dec.	2.04	.183	.695	.04	4.85	.354	....	....	7.58	.577

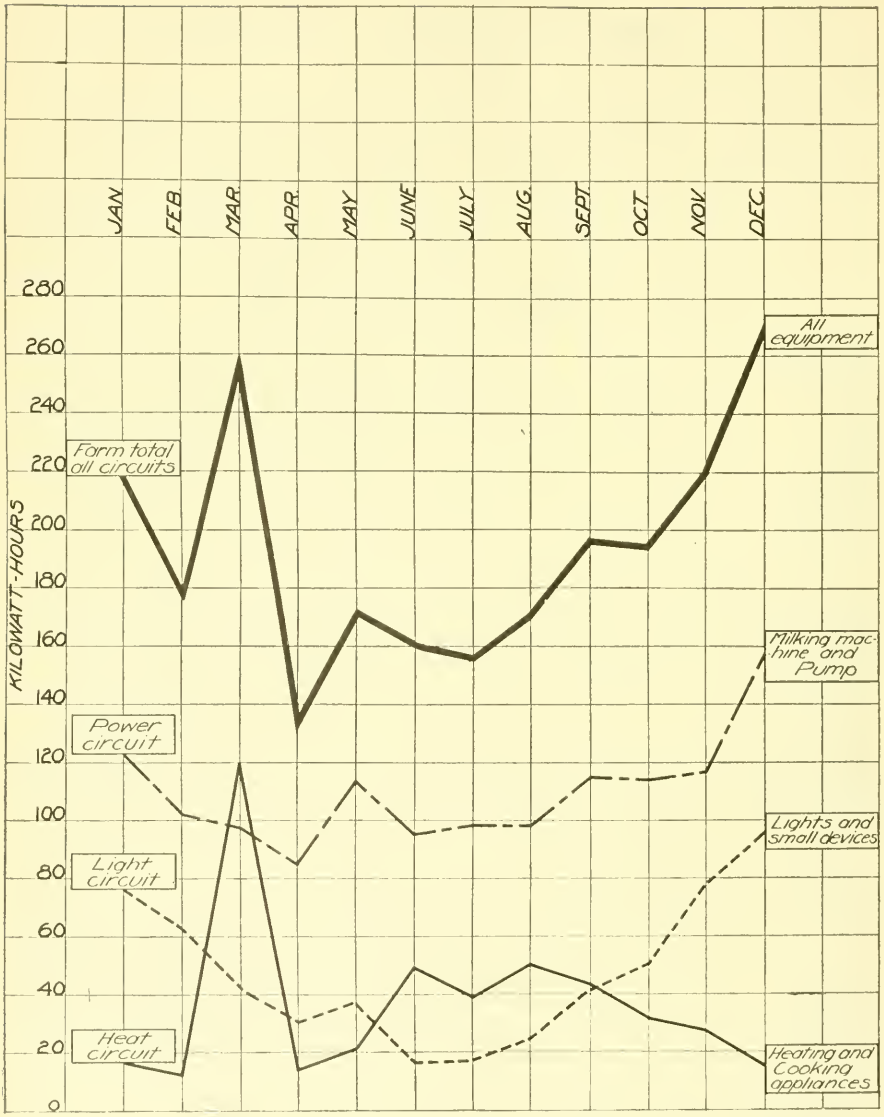

FIG. 4. Electric load for 1925 on Farm No. 3.

The combination wood-electric range accounts, in a large measure, for the trend of the heat circuit curve in Figs. 4 and 5. Being the only source of heat for a very large kitchen, it is used with wood as fuel most of the year, with the electric side as an auxilliary. The high consumption in March, 1925, was due to sickness, and is considered unusual for this season of the year. The high rise in August, 1926, is due somewhat to the installation of an electric hot water heater, although considerable canning was done throughout the summer.

The power circuit operates only the milking machine, milk cooling pump and a rarely used separator. A 2 H.P. motor working these through a countershaft

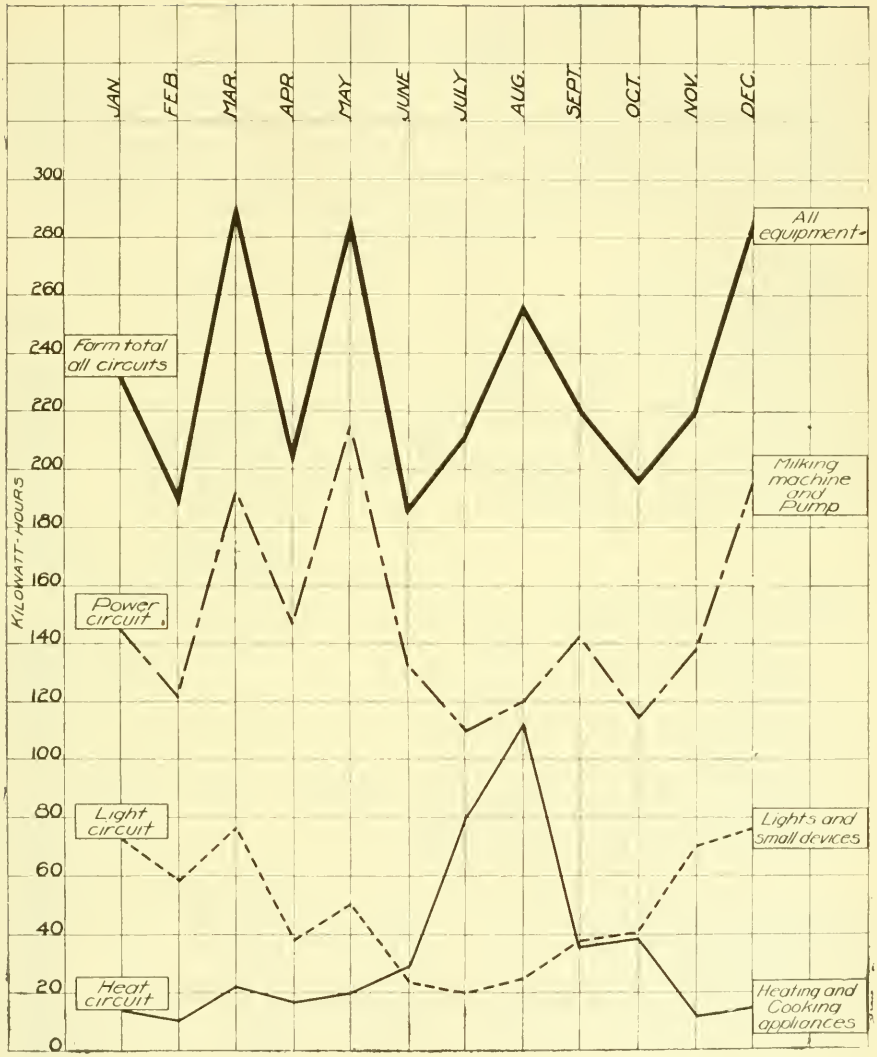

FIG. 5. Electric load for 1926 on Farm No. 3.

involves a very considerable loss in efficiency. An average of 25 cows are milked daily.

The greater power consumption in 1926 indicates increased milk production, and the fluctuations reflect such points in the herd management as freshening and drying up of the cows, changes in feeding schedules, etc.

It will be noticed that there is a repeated tendency to increase in March, April, September and December.

Assuming that a high summer peak load would be desirable, the general curve would respond if household and dairy electric refrigeration were installed. The curve also emphasizes the value, from an electric load basis, of developing such summer operations as hay hoisting, ensilage cutting, etc., even though of a short term type.

FARM NO. 4 (RETAIL DAIRY)

DESCRIPTION

Three to four-man farm. Family of six adults. Twelve room house. Large dairy barn with silo. bottling room, dairy wash room, refrigerator room, carriage house, and horse stable. 190 acres of which 65 acres are tillable. 27 head of cattle, 19 milked, 2 horses, 1 delivery truck, 1 pleasure car, modern machinery. Farm purchases some milk from near-by farm and retails 300 quarts daily in city two miles distant. Buildings wired in 1919 from near-by line without construction costs. Transformer of 10 K.V.A. capacity.

EQUIPMENT COSTS

The following inventory of equipment shows new installations in Italics:

Light Circuit Equipment

1.	Wiring house and barns	$215.00
2.	House lights—42 outlets, average 40 watt lamps	16.80
3.	Barn lights—9 outlets, average 40 watt lamps	3.60
4.	*Washing machine* (March, 1926)	155.00
5.	*Sewing machine motor drive* (Aug., 1926)	22.40
6.	Curling iron $2.75; (7) Toaster $6.00; (8) Percolator $8.00	16.75
9 & 10.	Radiant Heaters $12.00 & $8.00; (11) Battery Charger $16.50	36.50
12.	*Oscillating Fan* (Oct., 1926)	21.15
13.	*Vacuum Cleaner* (June, 1926)	59.50
14.	Separator Motor equipment	47.00
	Group Total	$593.70

Heat Circuit. (Installation of the heating circuit wiring is included in the following installation costs):—

15.	*Combination coal-electric range*	$227.50
	Installation costs (Dec., 1925)	142.61
16.	*Ironer*	129.00
	Installation costs (Aug., 1926)	29.20
17.	Flat Iron	6.75
18.	*Hot water heater*	64.50
	Installation costs (June, 1926)	11.78
19.	*Combination dairy cooling room & household refrigerator, new cooling room construction (material & labor)*	234.50
	Mechanical equipment (installed price)	510.80
	Electrical connections (May, 1926)	21.20
	Group Total	$1377.84

Power Circuit.	*Special circuit wiring*	$41.30
20.	Milking machine motor	75.00
	Installation	30.00
21.	*Deep well pump* (Nov., 1925)	331.92
	Installation, Plumbing $33.40; *Electric* $11.10	44.50
	Group Total	$ 522.72
	All equipment total	$2494.26

DISTRIBUTION OF EQUIPMENT COSTS

	Lighting	*Heating*	*Power*	*Household*	*Farmstead*
Per cent of appliances	66.7	23.8	9.5	80.9	19.1
Per cent of total cost	23.8	55.3	20.9	51.8	48.2
Per cent of circuit cost for appliances	88.	83.	78.		
Per cent of circuit cost for installation	12.	17.	22.		

Of the total equipment cost 83% is for appliances and 17% for installation.

Farm No. 4—Current Consumption and Costs. During the year 1925 only a lighting circuit was in use operating lights, milking machine and minor devices. Three separate circuits and all the equipment listed were in operation in 1926, ex-

cept the ironer which was installed in midsummer. The total consumption increased 267% over 1925, and attained a monthly average of 623.5 kwhs. The 1926 curve for the lighting circuit, as shown in Fig. 6, has much the same contour as that for 1925, but is of lower total consumption, due to the transfer of some of the equipment to other circuits.

The February peak in the 1926 heat circuit may be attributed to uneconomical use of current in becoming acquainted with the operation of new equipment. A

TABLE 4. Current Consumption and Costs for 1925 and 1926—Farm No. 4

	Light Circuit		Heat Circuit		Power Circuit		Monthly Total All Circuits		Daily Average All Circuits	
	Kilowatt Hours	Cost	Kilowatt Hours	Cost	Kilowatt Hours	Cost	Kilowatt Hours	Cost	Kilowatt Hours	Cost
1925										
January	195	$16.60	....	....	....	....	....	....	6.29	$0.535
February	227	19.16	....	....	....	....	....	....	8.10	.684
March	121	10.68	....	....	....	....	....	....	3.93	.344
April	219	18.52	....	....	....	....	....	....	7.30	.617
May	183	15.64	....	....	....	....	....	....	5.90	.504
June	120	10.60	....	....	....	....	....	....	4.00	.353
July	99	8.92	....	....	....	....	....	....	3.19	.287
August	100	9.00	....	....	....	....	....	....	3.22	.290
September	119	10.52	....	....	....	....	....	....	3.96	.350
October	156	13.48	....	....	....	....	....	....	5.03	.434
November	257	21.56	....	....	....	....	....	....	8.56	.718
December	230	19.40	....	....	....	....	....	....	7.41	.625
Year's total	2036	$174.08	....	....	....	....	....	....	....	....
Monthly average	169.6	14.50	....	....	....	....	....	....	....	....
Daily average	....	....	....	....	....	....	....	....	5.57	$0.47
Average rate per kwh.	....	$0.0855	....	....	....	....	....	....	....	....
Seasonal Daily Averages										
Jan., Feb., Mar.	....	....	....	....	....	....	....	....	6.00	$0.516
Apr., May, June	....	....	....	....	....	....	....	....	5.73	.491
July, Aug., Sept.	....	....	....	....	....	....	....	....	3.45	.309
Oct., Nov., Dec.	....	....	....	....	....	....	....	....	6.98	.591
1926										
January	263	$24.35	Start	Start	....	....	263	$24.35	8.48	$0.785
February	270	25.05	261	$8.58	....	....	531	33.63	18.96	1.20
March	174	17.16	171	5.88	....	....	345	23.04	11.12	.743
April	158	15.32	239	7.92	....	....	397	23.24	13.23	.774
May	148	14.10	315	10.20	....	....	463	24.30	14.93	.783
June	115	11.32	361	11.58	Start	Start	476	22.90	15.86	.763
July	45	4.60	739	22.92	80	$7.48	864	35.00	27.87	1.12
August	37	3.96	890	27.45	98	9.01	1025	40.42	33.06	1.30
September	68	6.44	952	29.31	117	10.45	1137	46.20	37.90	1.54
October	71	6.68	544	17.08	101	9.24	716	33.00	23.09	1.06
November	117	10.36	490	15.44	114	10.22	721	36.02	24.03	1.20
December	97	8.76	364	11.13	83	7.73	544	27.62	17.54	.890
Year's total	1563	$148.10	5326	$167.49	593	$54.13	7482	$369.72	....	....
Monthly average	130.2	12.34	484.1	15.22	98.8	9.02	623.5	30.81	....	....
Daily average	4.28	.41	15.94	.502	3.24	.296	....	....	20.50	$1.01
Per cent	20.89%	40.06%	71.18%	45.30%	7.93%	14.64%	100%	....	....	....
Average rate per kwh.	....	$0.0947	....	$0.0314	....	$0.0912	....	$0.0494	....	....
Seasonal Daily Averages										
Jan., Feb., Mar.	7.85	$0.739	7.45	$0.160	....	....	....	....	12.65	$0.899
Apr., May, June	4.62	.447	10.5	.326	Start	Start	....	....	14.18	.773
July, Aug., Sept.	1.63	.163	28.0	.866	3.20	$0.292	....	....	32.83	1.321
Oct., Nov., Dec.	3.09	.280	15.19	.475	3.23	.295	....	....	21.51	1.050

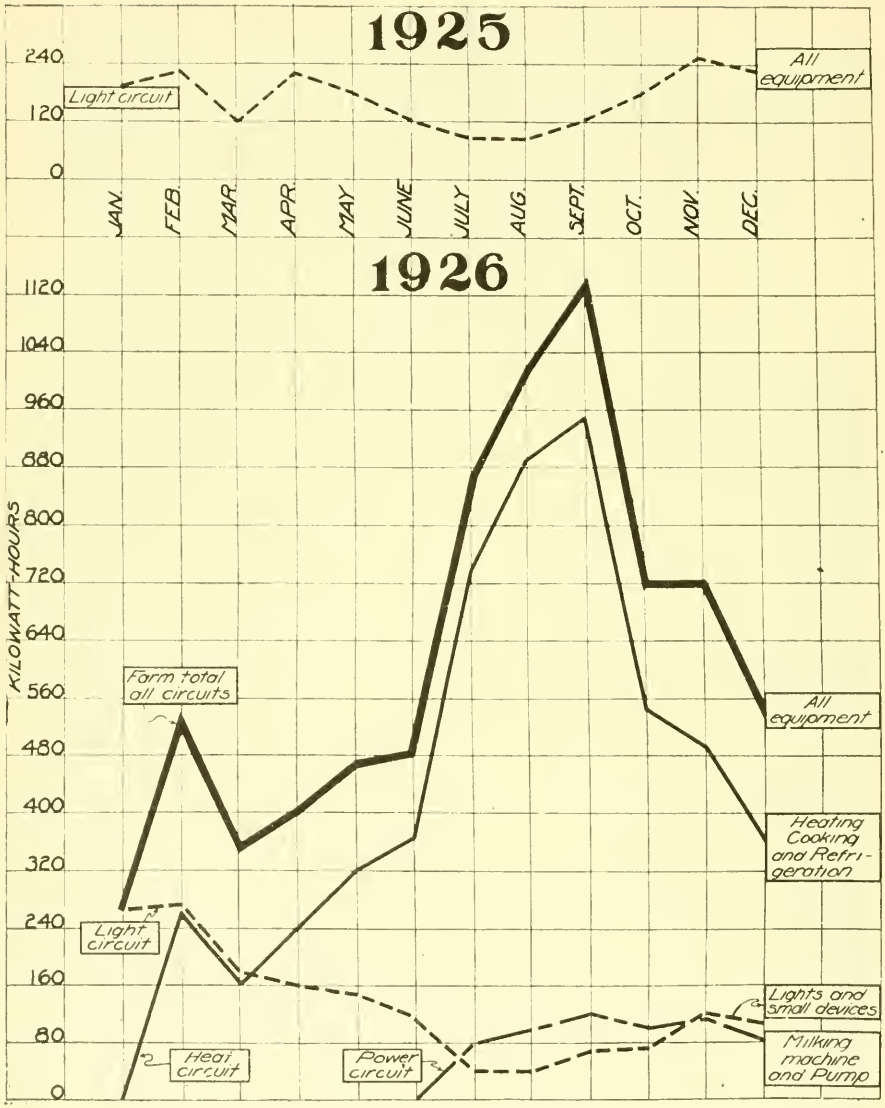

FIG. 6. Electric load for 1925 and 1926 on Farm No. 4.

very considerable increase will be noted during the warm months.

The power circuit has been installed for such a short time that the curve is not paricularly important. The transfer of the milking machine and water pump to this circuit is seen in the quick falling off of the light circuit curve.

The curve of total consumption shows clearly another case where a desirable summer peak load and one of considerable size occurs. The load building effect is also evident when compared to the consumption in 1925. The curves for the two years in August show an increase in consumption of 925%. Comparatively little farmstead equipment has as yet been developed on this place. Such short term operations as ensilage cutting, wood sawing, etc., are hired out.

FARM NO. 5 (FRUIT)

Fruit farms apparently offer less opportunities for electrification outside of the home than any of the other types of farms considered. At the same time, some of the problems arising such as dusting and spraying operations, insect trapping by lights, cider presses, etc., are complex and will require special attention to solve. This farm was the last one in the group to be equipped.

DESCRIPTION

Two-man farm. Family of two adults. Fourteen room house, with apartment for hired man and family. Medium sized stock barn, two buildings for handling and storing crop, garage, implement shed, ice house. 50 acres of tillage, hilly with over 2,000 apple trees. Produced 1600 barrels in 1924. Ten head of cattle, small flock of sheep, 2 horses, delivery car, pleasure car, modern machinery. Farm located one mile from state road, two miles out from village. Buildings wired in July, 1925. One extension of 1.5 miles carried service to 10 subscribers at a cost of $50 to $75 each for construction. Transformer of 10 K. V. A.

EQUIPMENT COSTS

The following inventory shows new equipment in Italics.

Lighting and Power Circuit Equipment.

1.	Wiring of house and barns	$450.00
2.	House lights—52 outlets	20.80
3.	Barn lights—8 outlets	3.20
4.	*Waffle Iron* $15.00; (5) *Tablestove* $14.00	29.00
6.	*Vacuum cleaner* (June, 1926)	59.50
7.	*Sewing machine* (Aug., 1926)	85.85
8.	*Washing machine* (Oct., 1926)	175.00
9.	*Water pump* (Sept., 1926)	238.50
	Installation costs and field extension	182.35
	Group Total	$1244.20

Heat Circuit Equipment. (Cost of heat circuit installation is included below).

10.	*Kitchen range*	$173.60
	Installation costs (Sept., 1926)	97.40
11.	*Household Refrigerator equipment*	325.00
	Installation costs (April, 1926)	22.30
	Group Total	$ 618.30
	All equipment total	$1842.50

DISTRIBUTION OF EQUIPMENT COSTS

	Lighting	*Heating*	*Household*	*Farmstead*
Per cent of appliances	81 8	18.2	63.7	36.3
Per cent of total cost	67 5	32.5	82.2	17.8
Per cent of circuit cost for appliances	73 2	79.		
Per cent of circuit cost for installation	26 8	21.		

Of the total equipment cost 76.1% is for appliances and 23.9% for installation.

Farm No. 5—Current Consumption and Cost. Table 5 shows the current consumption and cost on this farm from August, 1925, when electric service was obtained, to December, 1926. During 1925 only lights and a flat iron were in use. By the end of 1926 all equipment listed under "Equipment Costs" was in operation, but the electric range and water pump were not in service until fall and are, therefore, omitted from the record, which, however, does include the refrigerator equipment.

The total consumption even for 1926 does not indicate the increase that can be expected when all of the same equipment has been allowed to operate for a full year.

While the development of a load on this farm has not progressed very far, and what work has been accomplished has been somewhat delayed, Fig. 7 gives an indication of the tendency. The 1926 curve shows a pronounced peak at June, due principally to refrigeration, and extending over the summer months. The curve for 1927 will undoubtedly show quite an increase in this summer peak when the electric range and water pump will be in full operation.

TABLE 5. Current Consumption and Costs for 1925 and 1926—Farm No. 5

	Light and Power Circuit		Daily Average	
	Kilowatt Hours	Cost	Kilowatt Hours	Cost
1925				
August	14	$1.60	.451	$0.0516
September	20	2.20	.666	0733
October	28	2.84	.903	.0916
November	30	3.00	1.0	.10
December	58	5.24	1.87	.169
Total	150	$14.88	....	....
Monthly average	30	2.97	....	....
Daily average	....	....	.978	$0.097
Average rate per kwh.	....	$0.099	....	....
1926				
January	40	$3.80	1.29	$0.122
February	40	3.80	1.425	.135
March	25	2.60	.806	.0838
April	23	2.44	.766	.0813
May	35	3.40	1.129	.1096
June	59	5.32	1.965	.1773
July	48	4.44	1.548	.1432
August	35	3.75	1.129	.1209
September	30	3.00	1.0	.10
October	25	2.60	.806	.0838
November	32	3.16	1.066	.1053
December	40	3.80	1.29	.122
Total	432	$42.11	....	....
Monthly average	36	3.50	....	....
Daily average	....	....	1.18	$0.115
Average rate per kwh.	....	$0.09	....	....

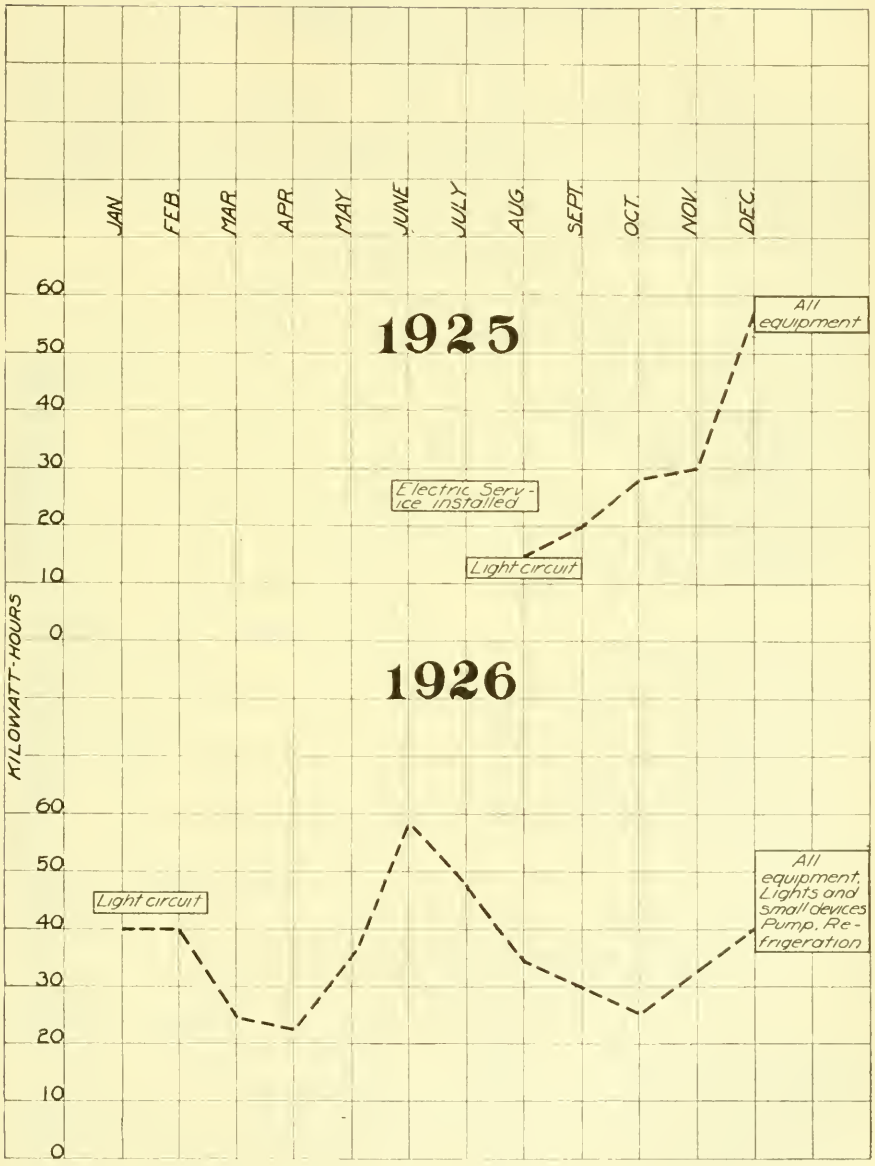

FIG. 7. Electric load for 1925 and 1926 on Farm No. 5.

FARM NO. 6 (POULTRY)

DESCRIPTION

Three-man farm. Family of three adults, two children. Ten room brick house. Hay and stock barn, garage, main laying house, and 20 brooder houses and shelters. 180 acres of flat, sandy loam of which 30 are tillable. Located one mile from town. 2500 laying hens, 20,000 to 25,000 broilers, 20,000 day old chicks, 2 horses, 1 cow, 1 delivery car, 1 pleasure car, modern machinery. 6000 egg incubator using coal hot water heat. Buildings wired seven years. No extra cost for line construction. Transformer of 7.5 K.V.A.

EQUIPMENT COSTS

The following inventory shows new equipment in Italics:

Light and Power Circuit Equipment

1.	Wiring House and Barn	$350.00
2.	Wiring Poultry Buildings and Fixtures	210.00
3.	House Lights—34 Outlets	14.60
4.	Barn and Poultry Lights—30 Outlets	12.00
5.	Washing Machine	150.00
6.	Dishwasher	125.00
7.	*Waffle Iron* $12.00; (8) *Heating Pad* $8.00	20.00
9.	Vacuum Cleaner	60.00
10.	*Poultry Drinking Fountains* (12) (tested only)	21.00
11.	*Brooder* (tested only)	20.00
12.	Water Pump—installed price	135.00
	Group Total	$1117.60

Heat Circuit Equipment

	General Heating Circuit Wiring (July, 1926)	$ 51.10
13.	*Kitchen Range*	285.00
	Installation Cost (July, 1926)	93.40
14.	*Hot Water Heater*	132.50
	Installation Cost (July, 1926)	23.47
15.	*Household Refrigeration*	250.00
	Installation Cost (May, 1926)	18.70
16.	Flat Iron	5.00
	Group Total	$ 859.17
	All equipment total	$1976.77

DISTRIBUTION OF EQUIPMENT COSTS

	Light and Power	*Heating*	*Household*	*Farmstead*
Per cent of appliances	75.	25.	68.8	31.2
Per cent of total cost	56.5	43.5	80.	20.
Per cent of circuit cost for appliances	73.	78.3		
Per cent of circuit cost for installation	27.	21.7		

Of the total equipment cost 76% is for appliances and 24% for installation.

Farm No. 6—Current Consumption and Costs. In considering the current consumed, as shown in Table 6, it should be borne in mind that the house lights, barn and poultry lights, washing machine, dishwasher, vacuum cleaner, and water pump were in use throughout both 1925 and 1926.

The heat circuit equipment was not installed until June, 1926, but in spite of this fact the total current consumption for 1926 shows 5998 kilowatt hours or an increase of 520%.

Something of the influence of poultry lights is shown by the figures for the winter months.

TABLE 6. Current Consumption and Costs for 1925 and 1926—Farm No. 6

	Light Circuit		Heat Circuit		Monthly Total All Circuits		Daily Average All Circuits	
	Kilowatt Hours	Cost	Kilowatt Hours	Cost	Kilowatt Hours	Cost	Kilowatt Hours	Cost
1925								
January	152	$12.75	....	....	....	....	4.90	$0.411
February	123	7.51	....	....	....	....	4.39	.268
March	108	9.02	....	....	....	....	3.48	.290
April	58	5.23	....	....	....	....	1.93	.174
May	91	7.15	....	....	....	....	2.93	.230
June	61	5.42	....	....	....	....	2.03	.180
July	47	5.12	....	....	....	....	1.51	.165
August	45	5.20	....	....	....	....	1.45	.167
September	51	5.60	....	....	....	....	1.7	.186
October	60	6.24	....	....	....	....	1.93	.201
November	53	5.60	....	....	....	....	1.76	.186
December	109	9.46	....	....	....	....	3.51	.305
Year's total	958	$84.30	. . .	. . .	. . .	. . .	. . .	. . .
Monthly average	79.83	7.025	....	....	....	....	....	....
Daily average	....	....	....	....	....	....	2.62	$0.2309
Average rate per kwh.	....	$0.0879	....	....	....	....	....	....
Seasonal Daily Averages								
Jan., Feb., Mar.	....	....	....	....	....	....	4.25	$0.325
Apr., May, June	....	....	....	....	....	....	2.30	.195
July, Aug., Sept.	....	....	....	....	....	....	1.55	.173
Oct., Nov., Dec.	....	....	....	....	....	....	2.40	.230
1926								
January	197	$15.45	....	....	197	$15.45	6.36	$0.498
February	200	16.60	....	....	200	16.60	7.14	.592
March	114	10.66	....	....	114	10.66	3.67	.343
April	69	6.12	....	....	69	6.12	2.3	.204
May	171	14.28	Heat Circuit		171	14.28	5.51	.460
June	185	15.45	Installed		185	15.45	6.16	.515
July	69	6.12	540	$15.15	609	21.27	19.64	.686
August	41	3.88	680	20.14	721	24.02	23.25	.774
September	49	4.52	840	24.70	889	29.22	29.63	.974
October	51	4.68	890	26.12	941	30.80	30.35	.996
November	52	4.76	760	22.42	812	27.18	27.06	.906
December	80	7.00	1010	29.54	1090	36.54	35.16	1.17
Year's total	1278	$109.52	4720	$138.07	5998	$247.59	....	....
Monthly average	106.5	9.126	393.3	11.50	499.8	20.63	....	....
Daily average	3.50	.30	25.86	.757	....	....	16.43	$0.678
Per cent	21.31%	44.23%	78.69%	55.77%	100%	....	....	....
Average rate per kwh.	....	$0.0856	....	$.02925	....	$0.0412	....	....
Seasonal Daily Averages								
Jan., Feb., Mar.	5.67	$0.474	....	....	....	....	5.67	$0.474
Apr., May, June	4.67	.393	Start	Start	....	....	4.67	.393
July, Aug., Sept.	1.72	.157	22.39	$0.652	....	....	24.11	.809
Oct., Nov., Dec.	1.98	.178	28.91	.848	....	....	30.89	1.03

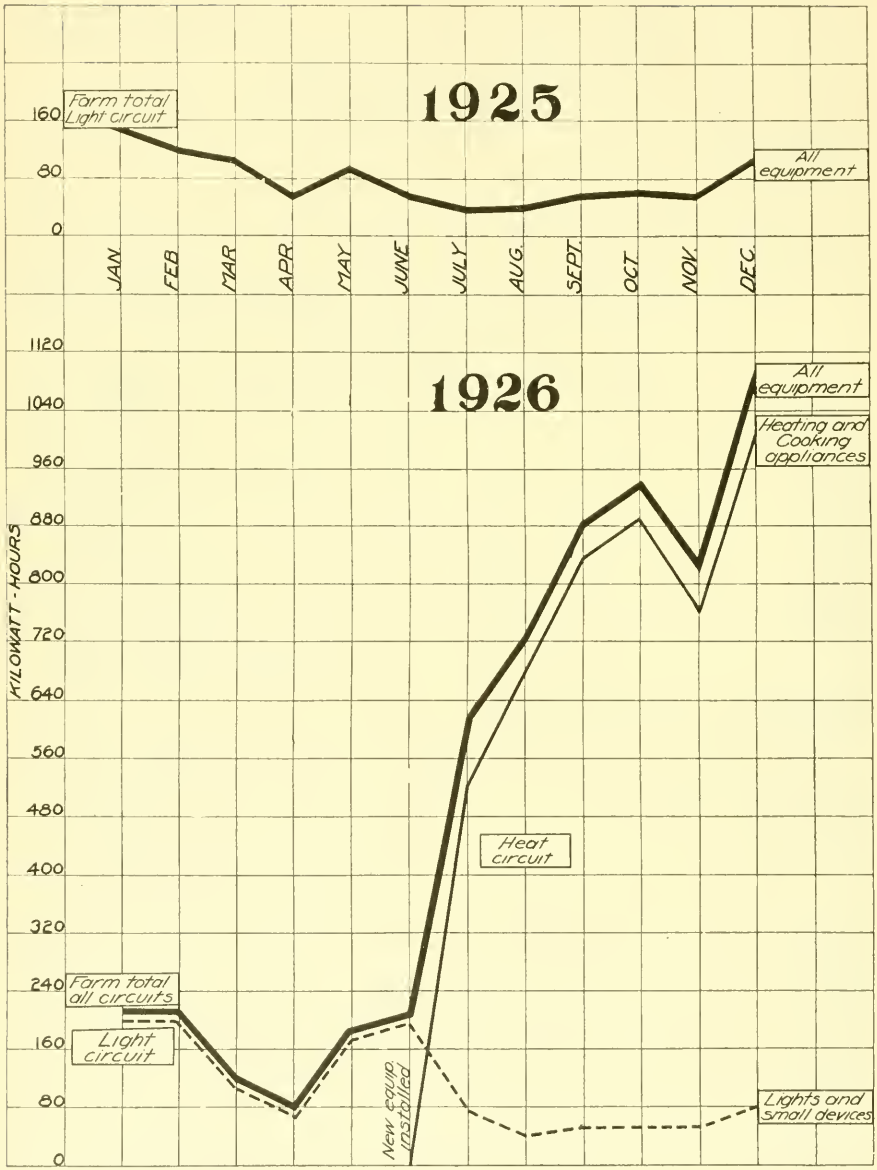

FIG. 8. Electric load for 1925 and 1926 on Farm No. 6.

The light consumption during the winter months, as shown in Fig. 8, rises as high as might be expected, considering that poultry lights are used.

The sudden rise in the heat circuit from November to December is due to experimental operation of certain equipment. Normally the curve would continue to decline somewhat at this season.

The curve of total consumption follows very closely the heating circuit curve from June to the end of 1926.

FARM NO. 7 (POULTRY)

DESCRIPTION

Three to four-man farm. Family of five adults and one child. Twelve room house, three story poultry barn, machinery storage barn, four laying houses, 21 brooder houses, repair shop, pump house and ice house. 184 acres of which 70 are tillable. 2600 laying hens, 15,000 broilers and an annual hatch of 20,000 chicks, 3 horses, 1 cow, 1 delivery truck, 1 pleasure car, modern machinery, 6,000 egg incubator, using coal-hotwater heat. 450 apple trees. Broilers and fresh eggs shipped to Boston and New York. Farm two miles from town. Buildings wired over 10 years without extra line cost. Transformer of 10 K.V.A.

EQUIPMENT COSTS

The following inventory shows new equipment in Italics.

Light Circuit Equipment

1.	Wiring house and buildings (estimated)	$400.00
2.	House lights—40 outlets	16.00
3.	Barn lights—20 outlets	8.00
4.	Washing machine	155.00
5.	Percolator $7.50; (6) Curling Iron $3.00; (7) Toaster $5.00	15.50
8.	*Sewing machine motor drive* (Aug., 1926)	22.40
9.	Radiant Heater $9.50; (10) Vacuum Cleaner $60.00	69.50
	Group Total	$686.40

Heat Circuit Equipment

	General Wiring on heat circuit	$107.43
11.	*Kitchen range* (June, 1926)	244.00
	Installation cost	82.70
12.	*Household refrigeration*	495.00
	Installation cost (May, 1926)	25.20
13.	*Ironer* (June, 1926)	160.00
	Installation cost	8.68
14.	*Hot water heater*—(June, 1926)	64.50
	Installation cost	19.18
15.	Flat Iron	5.25
	Group Total	$1211.94

Power Circuit Equipment.

16.	*Motor drive for water pump* (June, 1926)	$109.75
	Installation cost including 12 pole extension	162.92
17.	*Motor drive for shop equipment* (June, 1926)	75.00
	Installation cost	16.70
18.	*Feed mixer and elevator*	175.00
	Installation cost (Oct., 1926 and Jan., 1927)	59 00
19.	*Ultra-violet ray equipment* (Experimental only)	150 00
20.	*5 h. p. portable utility motor* (July, 1926)	275.00
	Installation cost	23.42
21.	*Hay fork hoist*	122.77
	Installation cost (July, 1926)	7.83
	Group Total	$1177.39
	All equipment—total	$3075.73

DISTRIBUTION OF EQUIPMENT COSTS

	Lighting	*Heating*	*Power*	*Household*	*Farmstead*
Per cent of appliances	47.6	23.8	28.6	66.6	33.4
Per cent of total cost	22.8	38.2	39.	55.8	44.2
Per cent of circuit cost for applances	80.6	80.	77.2		
Per cent of circuit cost for installation	19.4	20.	22.8		

Of the total equipment cost 81.5% is for appliances and 18.5% for installation.

Farm No. 7—Current Consumption and Costs. During 1925 only the lighting circuit equipment was in use, but in 1926 the rest of the equipment was installed in time to be available for use when most needed except for the water pump which was not in operation until June and the ironer which was placed in service in May.

The feed mixer and elevator and the ultra-violet ray equipment were in the experimental stage and were not used consistently.

The total consumption for 1926, shown in Table 7, is an increase of 100% over

TABLE 7. Current Consumption and Costs for 1925 and 1926—Farm No. 7

	Light Circuit		Heat Circuit		Power Circuit		Total All Circuits		Daily Average All Circuits	
	Kilowatt Hours	Cost	Kilowatt Hours	Cost	Kilowatt Hours	Cost	Kilowatt Hours	Cost	Kilowatt Hours	Cost
1925										
January	134	$17.92	....	....	....	....	....	....	4.32	$0.578
February	103	12.86	....	....	....	....	....	....	3.67	.459
March	89	11.18	....	....	....	....	....	....	2.87	.360
April	49	6.38	....	....	....	....	....	....	1.63	.212
May	45	5.90	....	....	....	....	....	....	1.45	.190
June	45	5.90	....	....	....	....	....	....	1.50	.196
July	32	4.34	....	....	....	....	....	....	1.03	.140
August	40	5.30	....	....	....	....	....	....	1.29	.170
September	44	5.78	....	....	....	....	....	....	1.46	.190
October	75	9.50	....	....	....	....	....	....	2.41	.306
November	139	17.18	....	....	....	....	....	....	4.63	.572
December	275	33.50	....	....	....	....	....	....	8.87	1.08
Year's total	1070	$135.74	....	....	....	....	....	....	....	....
Monthly average	89.1	11.31	....	....	....	....	....	....	....	....
Daily average	....	....	....	....	....	....	....	....	2.93	$0.37
Average rate per kwh.	....	$0.1268	....	....	....	....	....	....	....	....
Seasonal Daily Averages										
Jan., Feb., Mar.	....	....	....	....	....	....	....	....	3.62	$0.466
Apr., May, June	....	....	....	....	....	....	....	....	1.52	.199
July, Aug., Sept.	....	....	....	....	....	....	....	....	1.26	.165
Oct., Nov., Dec.	....	....	....	....	....	....	....	....	5.31	.654
1926										
January	235	$28.70	....	....	....	....	235	$28.70	7.58	$0.925
February	204	24.98	....	....	....	....	204	24.98	7.28	.892
March	108	13.46	....	....	....	....	108	13.46	3.48	.434
April	64	8.24	Start	$0.23	....	....	64	8.47	2.13	.282
May	46	6.02	40	2.90	Start	Start	86	8.92	2.77	.287
June	14	1.93	40	2.65	24	$4.10	78	8.68	2.60	.289
July	24	3.38	201	9.34	50	5.40	275	18.12	8.87	.585
August	22	3.14	221	10.14	49	5.35	292	18.63	9.41	.600
September	25	3.50	185	8.70	23	4.05	233	16.25	7.76	.541
October	34	4.58	184	8.66	22	4.00	240	17.24	7.74	.556
November	66	8.42	39	2.86	14	3.60	119	14.88	3.96	.496
December	176	21.62	26	2.34	7	3.25	209	27.21	6.74	.877
Year's total	1018	$127.97	936	$47.82	189	$29.75	2143	$205.54	....	....
Monthly average	84.8	10.66	117	5.97	27	4.24	178.5	17.12	....	....
Daily average	2.78	.35	3.82	.195	.883	.139	....	....	5.87	$0.563
Per cent	47.51%	62.29%	43.67%	23.26%	8.82%	14.45%	100%	....	....	....
Average rate per kwh.	....	$0.1257	....	$0.0510	....	$0.1574	....	$0.0959	....	....
Seasonal Daily Averages										
Jan., Feb., Mar.	6.07	$0.746	Start	Start	....	....	....	....	6.07	$0.746
Apr., May, June	1.36	.177	1.31	$0.09	Start	Start	....	....	2.67	.267
July, Aug., Sept.	.771	.108	6.59	.306	1.32	$0.160	....	....	8.68	.574
Oct., Nov., Dec.	3.00	.376	2.70	.150	.467	.117	....	....	6.17	.643

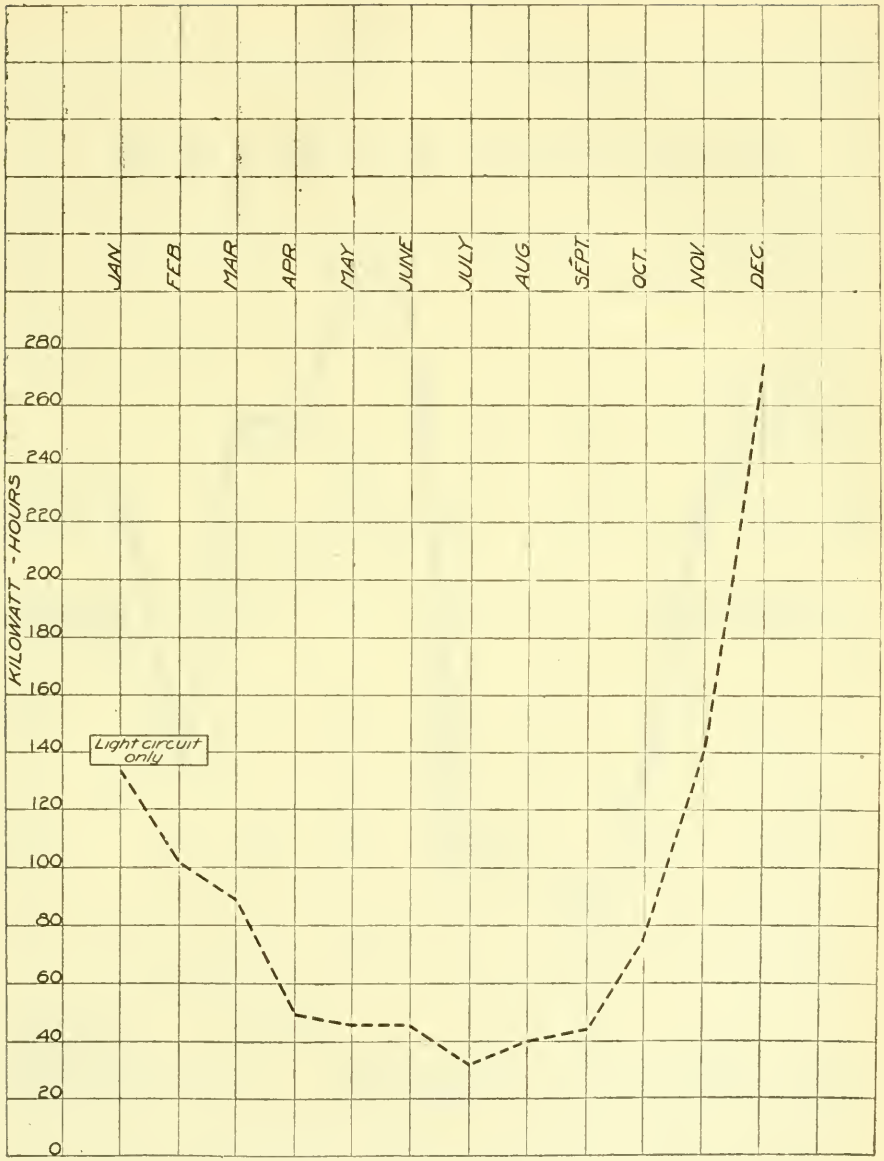

FIG. 9. Electric load for 1925 on Farm No. 7.

1925. The difference in value in the lighting circuit for the second year is due principally to transfer of some equipment to other circuits.

The lighting circuit curves for both 1925 and 1926, as shown in Figs. 9 and 10, are much the same and indicate a well fixed plan of operation. The high consumption at the beginning and end of the year shows clearly the load resulting from poultry lights used systematically and in sufficient amount.

The bulk of the load from the heating circuit was between June and November with a fairly consistent high consumption between July and October. The volume

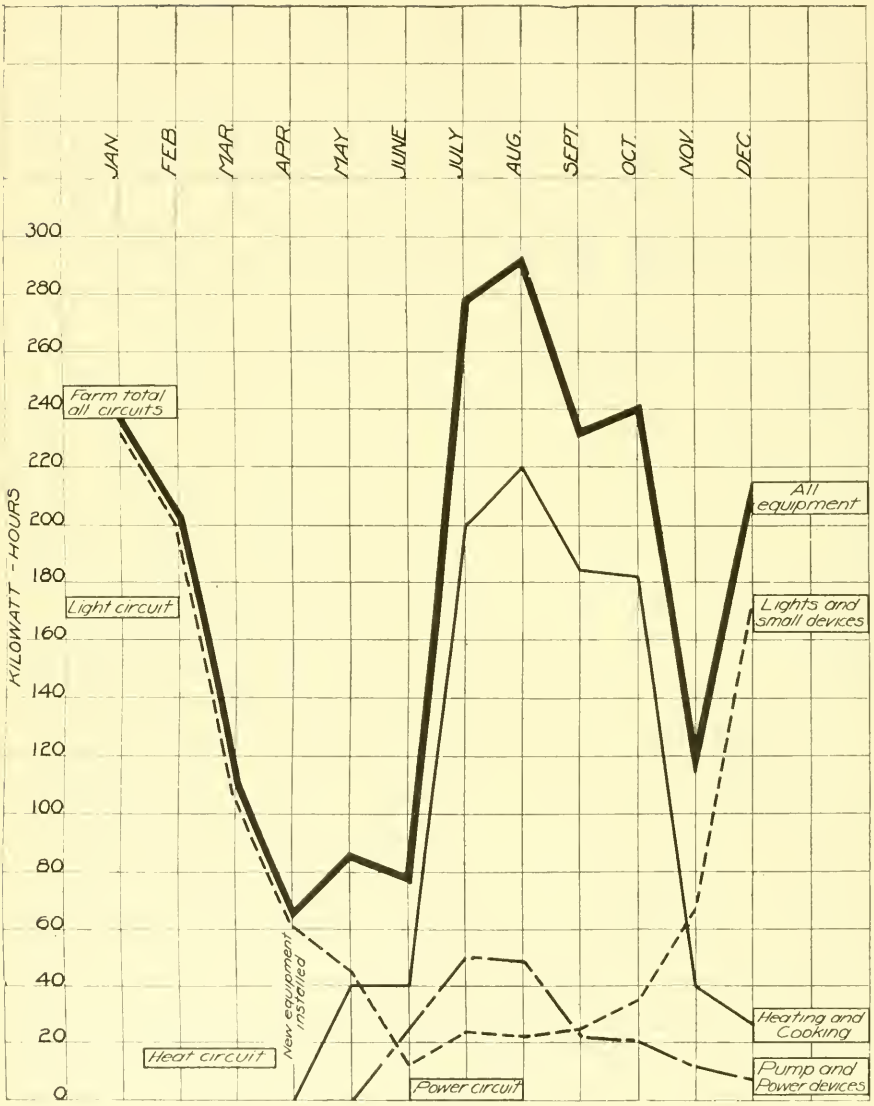

FIG. 10. Electric load for 1926 on Farm No. 7.

of canning, baking and preserving for a family of six is clearly evident. The equipment was not used extravagantly; in fact rather careful attention was given to the current consumed.

Aside from the shop equipment and water pump the greater part of the power circuit equipment has not passed out of the experimental stage. The time that this circuit has been operating is limited, but apparently a summer peak load may be expected if such short term operations as hay hoisting are made practical.

The increase in total consumption for the month of July amounts to 760% in favor of the 1926 curve, showing again the effect of load building.

CONCLUSIONS

The data given in Table 8 for the seven farms as a group show an average increase in consumption less than in three individual cases and more than in the four remaining, and indicate that the farm load in general can be materially increased.

The average 1925 consumption for all the seven farms of 1683 kilowatt hours increased to 4253 kwhs. in 1926. This increase of 152% is in spite of several different conditions. Farms 2 and 3 showed little or no increase due to being well equipped from the start; on the fruit farm, No. 5, only a small load could be built and the poultry farms, Nos. 6 and 7, did not get started until May and June. Farms 1 and 4 were operating for the full year. The variation ranges from a 520% increase to a 3.2% decrease. The latter is of no particular significance, being only a normal fluctuation in production or efficiency.

TABLE 8. Kilowatt Hour Consumption on All Experimental Farms for 1925 and 1926

	Farm No. 1 (Dairy)	Farm No. 2 (Dairy)	Farm No. 3 (Dairy)	Farm No. 4 (Dairy)	Farm No. 5 (Fruit)	Farm No. 6 (Poultry)	Farm No. 7 (Poultry)	Average All Farms
	Kwhs.	*Kwhs.*	*Kwhs.*	*Kwhs.*	*Kwhs.*	*Kwhs.*	*Kwhs.*	*Kwhs.*
Total 1925	1672	3362	2332	2036	300*	958	1070	1683
Total 1926	7694	3252	2770	7482	432	5998	2143	4253
Per cent increase	360%	3.2% decrease	12%	267%	44%*	520%	100%	152%
Average monthly consumption.. 1925	139.3	280.1	194.3	169.6	30*	79.83	89.1	136.5
Average monthly consumption.. 1926	641.1	271	230.8	623.5	36	499.8	178.5	354.3
Seasonal Daily Averages 1925								
Winter	3.16	5.21	7.27	6.00	....	4.25	3.62	4.92
Spring	2.13	10.55	5.13	5.73	....	2.30	1.52	4.56
Summer	4.31	12.58	5.71	3.45	....	1.55	1.26	4.81
Fall	7.56	8.42	7.45	6.98	....	2.40	5.31	6.35
1926								
Winter	13.22	5.39	7.93	12.65	....	5.67	6.07	13.40
Spring	17.5	9.79	7.37	14.18	....	4.67	2.67	9.36
Summer	28.9	11.72	7.44	32.83	....	24.11	8.68	18.95
Fall	24.23	8.65	7.58	21.51	....	30.89	6.17	16.50
Average rate 1925	$0.079	$0.101	$0.071	$0.085	$0.099	$0.088	$0.126	$0.093
Average rate 1926	.045	.104	.070	.049	.09	.041	.096	.071

* Estimated for a 12 months basis.

The consumption in each of the winter, spring and summer seasons of 1925 remained quite steadily in the neighborhood of 23% of the total for the year, and increased to about 31% in the fall. In 1926 the total consumption of all farms was distributed with 23% in the winter, 16% in the spring, 32% in the summer and 28% in the fall.

Comparing the two years, an increase in consumption occurred generally in all seasons, but most markedly in the summer, amounting to 292% for the seven farms, and showing how the peak of the farm load has been shifted to that season. Heating circuit equipment including refrigeration, electric ranges and water heaters are so far principally responsible.

The average rate for all seven farms in 1925 of 9 3-10 cents was reduced to 7 1-10 cents in 1926. Two companies reduced their rates during 1926 which had some effect in this direction; but the fact that with greater consumption there is usually a sliding scale to reduce the cost should not be overlooked. In fact, this is a point of consequence to those who can use electricity in considerable quantity.

Figures from the projects in other sections, organized in a similar way, may be of general interest at this point, though it should be recalled that all projects in this field are in varying stages of development. The average annual consumption on the Red Wing experimental line, Minnesota project, for ten consumers was 3,362 kilowatt hours for the year April, 1925, to March, 1926, or 280 kwhs. per month. A survey of 414 farms of all types using electricity in Virginia (non experimental) showed an average annual consumption per farm of 573.5 kilowatt hours, or 47.8 kwhs. per month. The Whitesburgh Pike line, a practical rural extension on the Alabama project, having 10 farmer customers, averaged 1050 kwhs. per farm in 1925 or 87.5 kwhs. per month. A six months record from the Illinois project shows that for the ten farms under test each consumed an average total of 1445 kilowatts or 241 kwhs. per month, indicating a possible total of 2890 kwhs. per year or thereabouts. The South Dakota test line consisting of 17 farms had, in the first year of operations, an average consumption per farm per year of 785 kwhs. or 65 kwhs. per month.*

While, as previously stated, the New Hampshire experimental farms are not meant to represent average conditions, the possibilities of building an appreciable electric load on farms in New England appear to be very favorable. Furthermore, the number of customers per mile of line is probably greater in New England than in other sections due to the smaller farms and generally more dense population, making a more desirable condition for rural extensions. From the data thus far it would seem that the farm house is the logical starting point in applications, and that further research and development of applications is desirable, especially for farmstead operations.

While the records are still too limited to draw many detailed conclusions, some general tendencies appear more or less fixed.

The lighting circuits on all except poultry farms do not vary greatly, except in the time of fluctuations, from those of any home. On poultry farms this consumption may rise considerably in the winter if poultry lights are used. This practice occurs at dusk and dawn, however, which brings it on the edges of the city night load.

At the present time power circuits, operating milking machines, water pumps and short term operations seem to have little well defined regularity throughout the year. While the consumption is quite irregular, it does remain within certain limits, in most cases, without any pronounced peaks. This is logical considering the type of equipment operated from it.

Heating equipment, such as refrigeration, ranges, ironers, water heaters, etc., produces the greatest effect in the total consumption and develops peak load in midsummer. Except in cases where only straight electric ranges are used, this circuit will taper off to a very small amount in the cold months. Where electricity is used for cooking the year around, a very appreciable consumption should take place, still coming to a peak in midsummer. If low winter consumption as well as high summer consumption is desirable, the combination range, which will probably be most popular with the majority of farmers, would probably produce this effect. At the same time if the cost of operating electric water heaters proves prohibitive, the above type of range makes it possible to care for this service for most of the year.

Reviewing the curves of total consumption, the peaks occurring in midsummer are repeated sufficiently to emphasize the point that they are characteristic of the farm load. The dairy farms, in general, tend to fall off in use in the winter months.

Poultry farms follow the same general trend until poultry lighting starts in the fall, which may bring in another peak in January. Fruit farms will probably have characteristics similar to dairy farms but with less total consumption.

The rural load is almost entirely a daytime load. Except for such appliances as refrigerators and water heaters, which may be run automatically, the farm practically stands at no load for most of the night. The former draw comparatively little current and the latter are seldom run automatically.

The appliances in use have three fairly definite characteristics; namely, (1) intermittent operation for short periods of time; (2) regularity in time of use; (3) operation to near full capacity of machine. This is, of course, exclusive of machines set for automatic operation.

*Figures are from C.R.E.A. bulletins 7, 6, and 5, Vol. II; 1926 report of Illinois project; and South Dakota Ext. Cir. 232.

RATES AND CIRCUITS

The rates used on the farms in the experimental group are those prevailing in the territory in which the farm is located. Special study of the subject of rates is not included in the plan of the project, and no particular material has been collected.

It appears that most of the utility companies in making a rate for rural customers have taken one of their established rates for city consumers and applied it to the rural extensions, temporarily. Inasmuch as the rural business of most of these companies has been comparatively small and adequate information on the subject scarce, very few have made a special rate which would be particularly adapted to this class of business. For this reason some of the rates in use at the present time are not entirely satisfactory from the standpoint of the farmer, while in other cases the rate may be quite practical.

That lighting and heating rates, or their equivalent in the form of a combination schedule, are practical and should be available to rural customers seems to be apparent, but just what position should be taken as regards what might be called power appliances is not so evident at present. Experience indicates that there is probably no advantage in using the usual commercial power schedule, which has not been drawn up for this type of load, for the purpose of providing service at a reduced rate. The characteristics of the power load are sufficiently different from those of commercial organizations to warrant separate consideration.

A combination rate, allowing the use of light, heat and power appliances and requiring but one meter, has some attractive features in this respect.

APPLICATIONS

The following pages give a brief description of the various individual appliances in use on the farms, current consumption or cost of operation, where it has been obtained, and some observations on the operation and use. For the sake of brevity the material is not given in detail. More complete information will appear in other reports.

CO-OPERATING MANUFACTURERS FURNISHING EQUIPMENT

The manufacturers co-operating by furnishing equipment on the consignment basis for the experiments are as follows:—Standard Gas Equipment Corporation, Aurora, Ill.; Malleable Iron Range Company, Beaver Dam, Wis.; The Maytag Company, Newton, Iowa; Sepco-Automatic Electric Heater Co., Warren, Penn.; Graybar Electric Company, New York City; Duro Pump Company of Boston, Boston, Mass.; Cooper, Hewitt Electric Co., Hoboken, N. J.; Kelvinator Corporation, Detroit, Mich.; The IceMaster Company, Haverhill, Mass.; The Gould Manufacturing Co., Boston, Mass.; Syracuse Washing Machine Corporation, Syracuse, N. Y.; F. S. Hardy & Company, Boston, Mass.; F. E. Myers & Brothers Company, Ashland, Ohio; General Electric Company, Schenectady, N. Y.; The Oakes Manufacturing Co., Tipton, Ind.; Lindemann & Hoverson Company, Milwaukee, Wis.; Westinghouse Electric & Mfg. Co., East Pittsburgh, Penn.; Eden Washer Corporation, New York City; Electric Household Utilities Corp., Boston, Mass.; Edison Electric Appliance Co., Chicago, Ill.; Landers, Frary & Clark, New Britain, Conn.; Deere & Company, Moline, Ill.; Singer Sewing Machine Co., New York City; Manning Bowman & Company, Meriden, Conn.; Fanstool Products Company and John P. Rainbault Co., New York City; American Ironing Machine Co., Chicago, Ill.; Detroit Battery Charger Co., Detroit, Mich.; Delco-Light Company, Dayton, Ohio; The Emerson Electric Mfg. Co., St. Louis, Mo.; Electric Controller Co., Greenfield, Ind.; Loudon Machinery Co., Albany, N. Y.; G. W. & C. A. Lane, Exeter, N. H.; The Russell Electric Co., Chicago, Ill.; The Ilg Electric Ventilating Co., Boston, Mass. and Chicago, Ill.; Wagner Electric Corporation, Boston, Mass.; Wellington J. Smith Co., Cleveland, Ohio; The Gillette Clipping Machine Co., Inc., New York City. Others Pending.

POWER & LIGHT COMPANIES RENDERING ADDITIONAL ASSISTANCE

Assistance rendered by the following electric companies, serving the experimental farms, has been particularly helpful.

Concord Electric Co. (Penacook branch), Concord, N. H.; Hampshire Road Power & Light Co., Salem, N. H.; Grafton County Power & Light Co., Lebanon, N. H.; Twin State Gas & Electric Co., Dover, N. H.; Contoocook Electric Co., Contoocook, N. H.; Franklin Light & Power Co., Franklin, N. H.; Exeter & Hampton Electric Co., Exeter, N. H.; Lawrence Gas & Electric Co., Lawrence, Mass.

FARM HOME EQUIPMENT

House Wiring. See Item No. 1 in each list of "Equipment Costs". The tendency of regulations and codes in New England is to require wiring to be done by a licensed and approved electrical contractor.

House Lighting. This is the most common use of electricity and usually the first to be suggested by an applicant for service. Properly installed, electric lights should be an aid in reducing the heavy loss from fire that occurs annually on New England farms.

Such devices as curling irons, vacuum cleaners, sewing machines, waffle irons and flat irons are commonly operated from a lamp socket.

The farm homes range in size from ten to fifteen rooms. While 60 to 75 watt lamps will be found in locations used considerably, the 40 watt size is the most common.

The many advantages of this system of lighting are too well known to require discussion, but much can still be accomplished in the way of education in correct and efficient illumination.

Maximums, as shown in Table 9, occur from late December to early February. The minimums occur, for the most part, in August.

TABLE 9. House Lighting Records on Experimental Farms

Farm Number	Outlets	30 Day Periods Approximate Kilowatt Hours			Extent of Record
		Minimum	Maximum	Average	
1	25	12	58	32.4	January to December '26
2	25	6	26	15.2	August '25 to December '26
3	55	11	59	35	July '25 to December '26
4	42	28	54	63.3	February to December '26
5	52	20	58	33.6	August '25 to December '26
6	34	18	52	36	June to December '26
7	40	8	50	26.6	May to December '26
Average	39	14.7	51	34.6	

Sewing Machines. The current consumed by motor-driven sewing machines is so small as to be difficult of accurate measurement and records are not given at this time. The labor of which they relieve the woman of the house, however, is quickly appreciated.

One standard portable machine and three standard type machines with attachable motor drive are in operation on the farms.

Vacuum Cleaners. Each farm is equipped with a vacuum cleaner which is now considered as a necessary piece of equipment. Information on operation and cost will be available. Fly trapping is an interesting new use for this appliance. One housewife rids the house and milk-room of flies by attaching the hose nozzle and moving it past the flies at dusk or dawn when they are still sluggish. They quickly disappear.

Water Supply. Very little question exists as to the improved efficiency of a water supply system operated by electric motor power; and while a long extension may involve a heavy first cost, the investment relieves the farmer of a great deal of trouble. On the dairy farms, large quantities of water are used for washing utensils, for steam boilers and for milk cooling. Applications on the farms are as follows:

Farm No. 1. A shallow well, automatic pump, furnishing water to the entire farm through a pneumatic tank system. One bathroom in the house.

Farm No. 3. A shallow well pump furnishing water for household use only (bathroom in house) from a storage tank in the attic.

Farm No. 4. Deep well pump drawing water from 75 ft. artesian well and supplying house (no bathroom) and barns. Drinking cups are used for the cows.

Farm No. 5. A deep well pump is required in this case to elevate the water from a shallow well to a concrete storage tank on the hill above. A windmill is

also connected. Water is supplied to house (has bathroom) and barns by gravity. A large quantity is required for spraying the fruit trees at critical times, and the electric pump furnishes a dependable supply.

Farm No. 7. A heavy duty pump which forces water from a meadow spring into an elevated tank on a hill, from which it flows by gravity to supply house, barns and poultry buildings.

Farm No. 6. Shallow well pump and small pneumatic tank or "fresh-from-the-well" supply system furnishing house (has bathroom), barns and poultry buildings.

No well defined regularity is apparent in the maximum and minimum consumption of current for water supplies. This is due to the variation in conditions locally, such as difference in wells, lack of rainfall, methods of handling stock in pasture, etc.

The motors used range from 1-6 to 1½ H. P.

TABLE 10. Water Pump Records on Experimental Farms

Farm Number	Head of Stock Supplied	Family of	30 Day Period Approximate Kilowatt Hours			Extent of Record
			Minimum	Maximum	Average	
1	48	6	26	43	39	January to December '26
3	..	5	3	5	3.7	July '25 to December '26
4	29	6	20	61	35	November '25 to December '26
5	18*	2	15	38	23	September to December '26
7	*	5	7	48	25.9	June to December '26
6	*	6	9	22	15.5	May to December '26
Average		5	13.3	36	23.7	

* Refer to Farm Description.

Electric Ranges. Six electric ranges are in use. Two general types are represented,—the straight electric range and the combination range which has a compartment for burning wood or coal. On two farms the electric range is used in addition to a wood or coal range. All ranges operate from separate heat circuits, or the equivalent, to obtain lower rates.

Farm No. 1. A straight electric range has been the only means of cooking for over a year. It is equipped with four surface plates, one large and one small oven, automatic time and temperature controls, master switch, automatic oven, ventilation and convenience outlet. The connected load is 9,000 watts.

Farm No. 6. A straight electric range has been the only means of cooking for five months. It is equipped with four surface plates, one large and one small oven, automatic time and temperature control and master switch. The connected load is 8,500 watts.

Farm No. 4. A combination coal-electric range assists the furnace in heating a large exposed kitchen. The coal fire-box, having two surface lids, may also be used for burning wood, and is equipped with a water front for heating hot water. (An electric water heater is also in use.) The electric section of the range is equipped with four surface units and standard size oven. As there is no oven heated by the firebox, it is necessary to do all oven baking and cooking by electricity. No automatic controls are used and the regulation of temperature is accomplished manually, guided by an oven thermometer.

Farm No. 3. A very complete combination wood-electric range is in use. The wood burning section has four surface lids and also heats a standard size oven. Brass coils in the fire-box provide hot water which is heated electrically when the fire is out, or in emergency. Three surface plates and a separate oven are heated electrically. No automatic controls are used; temperatures are maintained manually through the three-way switches guided by an oven indicator. Under the existing condition the electric section holds the position of an auxiliary cooking unit which is utilized only during the extremely warm days of summer, for emergency, or to meet the requirements in a rush season, such as canning time, when all heating equipment is needed.

Farm No. 5. A wood range has been retained to heat the kitchen, and a separate electric range installed. The electric range has three surface burners, a standard size oven, master switch and automatic time and temperature controls. This has been installed for so short a time that the records are withheld.

Records for the five farms are given in Table 11.

Farm No. 7. In the large kitchen both a regulation wood range, supplementing the furnace, and an electric range are used. The volume of work carried on indicates that the combined capacity of the two ranges is advisable. The electric range has four surface plates, one large and one small oven, a warming closet, and automatic time and temperature controls.

TABLE 11. Kitchen Range Records on Experimental Farms

Farm Number	Family of	Type of Range	30 Day Periods Approximately Kilowatt Hours			Extent of Record
			Minimum	Maximum	Average	
1	6	Straight electric. . . .	96	281	196	December '25 to December '26
3	5	Combination (wood)	4	102	26	August '25 to December '26
4	6	Combination (coal) .	171	429	282	January to December '26
5	2	Electric range with wood range.	No	records as	yet	October to December '26
7	5	Electric range with wood range.	14	140	74	June to December '26
6	6	Straight electric. . . .	244	295	260	July to December '26
Average all types	5		106	234	167	

Both types of ranges are found practical and more desirable for cooking than coal or wood ranges by the housewives. Cost of operation is not considered excessive.

Initial cost of equipment is probably a greater factor with rural buyers than with city residents.

While the availability of wood seems to have had no pronounced influence for or against the installation of electric ranges, it does have a marked influence on the type of range selected and the resulting current consumption.

Farm ranges are required to carry maximum loads very frequently; therefore rugged construction is desirable. A master switch for protecting the appliance during electrical storms should be required, if not provided by the manufacturer.

Black enamel or black enamel with white panel trim is recommended for durability and ease of cleaning.

Automatic controls, both time and temperature, are undoubtedly very important for economical operation, and are to be recommended. The lack of such control on Farm No. 4 is undoubtedly responsible in part for the relatively heavy current consumption.

Local conditions, such as heating the kitchen, providing large quantities of hot water and the local fuel situation, are important to consider.

Year-around baking, summer canning and cooking extra heavy meals for summer help are the outstanding uses.

The total current consumption of ranges in farm homes will probably be higher than those operated in the city due to the greater amount of cooking done. The maximum consumption shown in the table occurred regularly in August and September. The minimum varies from December to April.

Fireless Cooker. Fireless cookers appear to be of little practical value after the installation of an electric range, due to the fact that the range ovens are able to do even more than the cooker is capable of. No record of a fireless cooker used alone is available at present.

Household Refrigeration. Electric household refrigeration appears now to be an outstanding success. Its many advantages are as fully recognized by the farmer and his wife as by any city user.

Farm No. 1. This commercial unit consists of a refrigerator of 5½ cubic feet capacity with the mechanical equipment mounted in the base. It is located in the kitchen where it is subjected to average house temperatures. The cabinet is metal, cork-lined. The equipment is operated 12 months of the year.

Farm No. 2. The refrigerator is built into the house with an ice-filling door out through the wall to permit outside icing in the past. It was built by a local carpenter and contains no insulation. It is considerably larger than the average refrigerator in cubic feet of storage space. During the winter months the current is shut off and natural temperatures utilized by means of the outside door.

Farm No. 4. A small section of the dairy cooling room is finished in cabinet form for the storage of food. The room is within reasonable distance of the kitchen door so that the plan has proved very practical. The cooling room is somewhat larger in size, and the cost of operation is increased in proportion. (See Cooling Room No. 4.) It is planned to operate nine months with electricity and three months with natural temperatures.

Farm No. 5. The refrigerator contains 11 1-3 cubic feet storage space and has no special insulating material in its wall construction. It is located in a moderately cool room and used for only nine months out of the year. The compressor unit is in the basement immediately underneath.

Farm No. 6. The refrigerator contains about 6½ cubic feet storage space and is well insulated with cork. Twelve months operation is practiced against average house temperatures.

Farm No. 7. This is a cork insulated, wood case, commercially made, electric refrigerator, with the mechanical unit built into the cabinet. It has nine cubic feet of storage capacity and operates in a room which stands at average household temperature. The equipment is used for only nine months of the year.

TABLE 12. House Refrigerator Records on Experimental Farms

Farm Number	Family of	30 Day Periods Approximately Kilowatt Hours			Extent of Record
		Minimum	Maximum	Average	
1	6	30	40	37.8	August to December '26
2	3	0	97	39.5	August '25 to December '26
4	6	House Refrig	erator combin	ed with Dairy Cooler	
		(See N	o. 4, Dairy C	ooling Room)	
5	2	0	35	23	August to December '26
6	5	0	85	37.2	June to December '26
7	6	17	56	39	May to December '26
Average	5	9.4	62.5	35.3	

Any well-made refrigerator, if properly insulated, is believed suitable, but proper insulation is an important factor in economical operating costs. No specific size is in demand though boxes of somewhat larger size than those used by the average city family are favored.

The operation of the refrigerators for nine months and the utilizing of natural temperatures for the remaining three is at present the most common practice. Two farms, however, are already operating on a 12-months basis, and this will be more generally practiced, as the advantages and economy in food spoilage from using a controlled temperature are appreciated.

Maximum consumption for household refrigerators occurs during July, August or September. Where used for 12 months under excessively warm conditions, this might not hold true. Minimum consumption is reached in the cold months.

Dishwashers. Two dishwashers of the propeller type have been in use for a considerable length of time on two of the farms. One is considered by the housewife practical, while the use of the other has been discontinued.

Farm No. 3. This machine is rectangular in shape, having one removable rack large enough to hold the dishes from a family of five. One teakettle of water is required for washing and one for rinsing. Dishes are as easily placed in the washer as in a dishpan and may be left in the rack to steam dry. A common soap powder is used. The water is drawn off through a spigot valve, which may

be connected with the plumbing if desired. When not in use the machine forms a table surface by means of a hinged cover. Two kilowatt-hours per month is regularly used for washing the dishes three times a day.

Farm No. 6. This washer is circular in shape and contains two racks, one above the other, for holding the dishes. The washing action is satisfactory, but the housewife feels that she can handle the dishes in the dishpan with the same amount of effort and does not have to take care of the washer after the operation is over. Use of the machine has been discontinued.

The development of a dishwasher which will meet general approval in practical use is of great interest to the farm housewife because of the quantity of dishes handled. The failure to handle pots, pans and kettles is the most common disadvantage mentioned. The quantity of water required is important, and the propeller washing action is very effective.

Successful operation appears to involve the size and shape of the machine and the rack for holding the dishes. One single rack of large capacity is desirable.

Kitchen Ventilating Fans. One such device is in use and is found to be very effective in removing cooking odors, steam and gases from the kitchen. Fans are generally furnished mounted on a panel which is easily attached to a window in such a way that the sash may be opened or closed as desired. Records of current consumption and use will be available.

Electric Water Heaters. Results obtained from the use of electric water heaters emphasize the need of consideration from two distinct angles: (1) the degree of mechanical and electrical efficiency of the heater itself; and (2) the cost of operation. It appears now that the latter point is the limiting factor to their adoption and successful use.

The heaters in use in the experiment have given, without exception, a very high grade service. The only difficulty experienced during the past season was one case of a loose connection—a fault of installation.

Farm No. 1. This complete unit consists of a 15-gallon insulated tank with automatic and manual current control, so that a continuous supply may be main-

TABLE 13. Hot Water Heater Records on Experimental Farms

Farm Number	Family of	30 Day Periods Approximately Kilowatt Hours			Extent of Record
		Minimum	Maximum	Average	
1	6	116	280	191	June to December '26
3	5	3	41	15.2	July to December '26
4	6	5	280	139	June to December '26
7	5	..	26	15	June to December '26
6	6	480	580	548	July to December '26
Average		120	241	182	

tained or water may be heated as needed. The equipment is located in the bathroom, and furnishes hot water also for the kitchen a short distance away. Water is heated only as needed during the week, and on days when a large amount of water is used is heated automatically. No other water heater is used.

Farm No. 3. A circulation type heater is attached to the original 30 gallon, uninsulated range boiler, and is used only as an auxiliary, for emergency or in the warm summer months. Insulation of the tank was omitted because of its constant exposure to the heat of the range. The bulk of the hot water used during the year is heated from a coil in the firebox of the combination range. Water is supplied to the kitchen and bath. The current is turned on and off by hand.

Farm No. 4. A circulation-type heater is attached to a 30-gallon range boiler which furnishes water to the kitchen only. The boiler has been uninsulated for the past season due to its close proximity to the firebox of the combination range. The electric heater is used mostly during the summer months and in emergencies. The current is turned on and off manually, for the most part, to reduce the cost of operation.

Farm No. 7. This is also a circulation type heater connected to a 40-gallon insulated kitchen range boiler, which furnishes water to the kitchen and bathroom. It is used as an auxiliary and during the hot summer months. During the greater part of the year the hot water is supplied from a water front in the firebox of the regulation kitchen range. The current is controlled manually.

Farm No. 6. As in the first case, this is a complete unit consisting of a 15-gallon insulated tank with automatic and manual current control. The heater is located in the basement and furnishes water to the kitchen and bathroom located on the floor above. The run of pipe from the heater to both of these locations is particularly long and, at the same time, these pipes are exposed to quite cool temperatures the year around. Both intermittent and continuous operation have been employed, the latter to supply 24-hour service. This is the severest test to which any of the heaters have been subjected, and is at the same time typical of a type of service which many people have come to expect.

Results are given in Table 13.

The heaters have given a high degree of service and are considered very desirable and efficient from the mechanical and electrical standpoint.

The cost of operation for the type of service which the people are accustomed to, however, is excessive.

The circulation-type heater that can be attached to, and thereby make use of, the present boiler equipment is favored because of its lower first cost and apparently lower cost of operation. Insulation of storage tanks and possibly pipe lines is an important point.

Particular pains should be taken to locate the heater in a central position, if possible, with respect to the points where the water will be used in order to cut down the length of pipe exposed to radiation. Exposure of these pipes to cold should be avoided.

TABLE 14. Washing Machine Records on Experimental Farms

Farm Number	Tubsful of Clothes	Family of	30 Day Periods Approximately Kilowatt Hours			Extent of Record
			Minimum	Maximum	Average	
1	3–4	6	1	3	1.6	January to December '26
2	3	3	2	8	5.7	August '25 to December '26
3	4	5	2	3	2.3	July '25 to December '26
4	6–7	6	3	4	3.5	March to December '26
7	5	5	1	2	1.7	June to December '26
6	2–3	6	1	2	1	May to December '26
Average	4	5	1.6	3.6	2.6	

Washing Machines. The washing machine is considered important on the farm where washings are large and heavy and access to commercial laundries often impossible. All farms in the experimental group are equipped with electric driven washing machines representing cylinder, vacuum cup and submerged

TABLE 15. Flat Iron Records on Experimental Farms

Farm Number	Tubsful of Clothes	Family of	30 Day Periods Approximately Kilowatt Hours			Extent of Record
			Minimum	Maximum	Average	
1	3–4	6	4	10	7.8	January to December '26
3	4	5	4	9	5.8	July '25 to December '26
4	6–7	6	7	10	8.6	March to September '26 (Now using ironing machine)
6	2–3	6	5	10	7	May to December '26
Average	4	6	5	9.9	7.3	

gyrator types. Like the water supply system for the man of the farm, the washing machine is likely to be the housewife's first choice. Table 14 gives the results to date. The current consumed by washers is fairly regular for most of the year, with the maximum occurring in mid-summer.

Flat Irons. The advantages of the electric flat iron are well known. There have been cases where the flat iron was used several years before electric lights were installed. With the introduction of an ironing machine the use of the flat iron is practically eliminated except for occasional pieces.

The maximum consumption shown in Table 15 occurs in July and August and the minimums in April and May.

Ironing Machines. The ironing machine is likely to be as important in the farm home as in the city, due to the greater amount of washing and ironing which is done. The use of this machine almost eliminates the flat iron. Much less time is required and practically everything may be ironed. The small household size machines, having a 30″ to a 36″ roll with one open or semi-open end, are preferred on account of their compact size and improped operating features. Two ironing machines have been obtained up to this time, though it is expected that more will be available. The desirability of ironers lies in the lessening of fatigue, increasing the pleasure of the work, shortening the time of operation and increasing the quantity of material ironed. These appliances are operated from the separate heating circuits to obtain lower rates.

Farm No. 4. This machine of the semi-open end type, having a 26″ roll operated by a 1-6 h. p. motor, requires 1650 watts for the heating shoe. A movable table leaf in front controls the operation. When not in use for ironing, a hinged top may be turned down protecting the working parts and providing a table surface.

Farm No. 7. This 3,000-watt ironer with a 30″ roll and one open end has proven very practical. It is conveniently arranged in the way of controls, and provision is made for easy oiling. It may be stored in a comparatively small space.

Results are given in Table 16.

TABLE 16. Ironing Machine Records on Experimental Farms

Farm Number	Tubsful of Clothes	Family of	30 Day Periods Approximately Kilowatt Hours			Extent of Record
			Minimum	Maximum	Average	
4	6–7	6	17	23	18.3	August to December '26
7	5	5	6	9	7.2	June to December '26
	Average		11.5	16	12.7	

The length of roll has proved a factor in economical operation, and of the two machines the 30″ roll has been found more practical. The personal factor is also important and the housewife can reduce the current consumption greatly, and incidentally the ironing time, by learning how to use the machine. Very

TABLE 17. Barn Lights Records on Experimental Farms

Farm Number	Outlets	30 Day Periods Approximately Kilowatt Hours			Extent of Record
		Minimum	Maximum	Average	
1	16	0	11	5.5	January to December '26
2	22	1	13	4.3	August '25 to December '26
3	20	1	12	13.9	August '25 to December '26
Average	19	.6	22	7.9	

little ironing is found that the machine will not handle. Initial cost is considered somewhat high.

FARMSTEAD EQUIPMENT

Barn Lighting. The fire hazard of flame lights for barns is so great that practically all farmers are glad to remove this possible danger with electric lights. The additional advantages need no discussion.

All barns in the group are wired for this service, and the tendency is to increase the number of outlets and, therefore, the quality of illumination. Forty watt lamps are most commonly used.

Records are given in Table 17.

Shop Equipment. Probably the most useful articles in a farm shop are an emery wheel, grindstone, drill press and combination rip and cross-cut table saw. Two such shops are in operation and are found to be of great value in repair and upkeep of equipment and property. Especially when break-downs occur in rush season is the quick electric power appreciated. The cost of operation is very low—1 kilowatt hour being the maximum during the past season. This is considered lower than could be regularly expected due to the small amount of work done.

Wood Sawing. Sawing wood with a 5 H. P. portable motor, using a 24-inch saw, showed, by a demand meter, that 3 H. P. was utilized. The usual run of farm woodlot growth was cut, ranging from 2″ to 7″ in diameter. Some 7″ frozen maple was included and was easily handled by the motor which provided steady, even power at all times.

Fertilizer Grinding. Commercial fertilizers are frequently received in such a hard lumpy condition that they cannot be mixed or fed through the distributing machines. Pulverizing by pounding is usually resorted to.

A discarded feed grinder was adapted and found to quickly and easily do the work. A portable utility motor was used as power.

Portable Motors. Two portable motors of 7½ and 5 H. P. respectively are being used, the former on a dairy farm (1) and the latter on a poultry farm (6). The past season's work has been largely concerned with finding as many suitable operations as possible. The question in this case is to determine whether there is sufficient work for them to do to justify their cost. Short term operations have so far offered the most practical openings, and during the past season they have been successfully used for hay hoisting, fertilizer grinding and sawing wood. An attempt to cut and elevate ensilage with the 7½ H. P. was unsuccessful, though there are indications that it may be accomplished by a new method of operation just being introduced. Until this method is proven practical in the field, not less than 10 H. P. should be considered for ensilage cutting with the prevailing practice of high-cutter speeds and forced feeding that is common on our farms today.

Due to the interruptions in testing the adaptability of the equipment, current consumption readings for the past season are not accurate in all cases and, therefore, omitted.

FRUIT EQUIPMENT

An Apple Sorter and Grader. The use of such a machine is fast becoming a necessity if New England apple growers are successfully to meet competition from Western and Southern growers. Such machines may be privately owned or operated by a commercial packing house.

The test here reported was made in cooperation with the Horticultural Department of the University, using the crop from the college orchards. The maximum capacity of the grader is close to 200 packed boxes a day (9 hours) with experienced help. The grading and packing occupied 13 days or a total of 93 hours, during which time the equipment was operated intermittently. The help used consisted of 4 to 5 packers, 2 receivers and graders, 1 nailing and general. Only two of these eight were experienced workers.

A total of 2100 bushels of apples were put through the machine, producing 1750 boxes. Sixty per cent of these were A grade, and 40 percent were B grade. Twenty-five kilowatt hours of electricity were consumed by the ½ h. p. motor for the entire operation. The failure of current for approximately two hours was the only interruption that occurred. Seven 75-watt electric lights were

required to illuminate the working space about the machine which measures 20x40 feet. The current consumed by these lamps for the entire period of operation was 52.5 kwh.

Graders of this type cost in the neighborhood of $800.

The cost of operation per bushel was .014 kwh. and the cost for lighting .03 kwh. per bushel.

DAIRY EQUIPMENT

Milking Machines. Milking machines are considered as thoroughly practical and standard equipment in the New England section. Many dairy farmers have been operating them for quite a few years with gas engine power if not with electric. The most important point is to keep the equipment clean and sterile. With this well taken care of, very little difficulty arises from their use. Three hours per week should be sufficient for this.

Each of the four dairy farms is equipped with stationary installed milkers, three of which are double units (3 units per farm) and the other machine operates three single units.

Various attempts have been made to determine the number of cows necessary to justify the use of this machine. This, however, does not work out consistently because of the human factor. Milkers have been installed for as few as ten cows, and with the new small size, portable type of machines now available this may be more generally practical.

There is no standard power requirement for milking machines. Each make varies from another. Unless definite information is at hand, milkers should be over-powered to be on the safe side. Two horse-power is the average required on the four farms.

In the case of Farm No. 3 a 2 h. p. motor operates, through belts, pulleys and a line shaft, the milking machine, milk cooling pump and cream separator. It will be noticed that the power consumption on this place exceeds that of farms milking many more cows, which is a clear-cut example of the loss of power in a line shaft. The operating cost is thus increased 60 to 70 percent.

TABLE 18. Milking Machine Records on Experimental Farms

Farm Number	Number of Cows	30 Day Periods Approximately Kilowatt Hours			Extent of Record
		Minimum	Maximum	Average	
1	36	55	145	65.1	January to December '26
2	36	86	139	111	August '25 to December '26
3	27	98	160	134	July '25 to December '26
4	19	48	65	56.5	January to December '26
Average	30	71.7	127	91.5	

Separators. New England is a whole milk producing section, and the use of current for separators has dwindled to practically nothing. The four dairy farms are equipped with them, but the records show that the current consumption for months at a time stands at zero. They are used only very occasionally.

Milk Cooling with Water. Several methods are advocated for removing the animal heat from milk immediately after milking, *i.e.* reducing the heat from body temperature to about 50° F. Up to the present time but one of these methods has been experimented with, namely that of circulating cold well-water through specially designed cooling cones over which the milk flows in a thin sheet. This is a well known and established practice among dairymen, and undoubtedly economical, if plenty of cold water is available. The ¼ h. p. motor which operates the circulating pump consumes 10 kwh. as a maximum in July and August and reaches a minimum in February of 4 kwh. The average for the year is 7.8 kwh. Three hundred quarts of milk are cooled daily.

Bottle Washing Brush. A 1-6 h. p. motor is used to operate a bottle brush which washes 300 bottles a day. Many farmers who operate steam turbine brushes which require 25 to 50 pounds steam pressure find that the cost of

fuel and labor for the boiler is quite high. If steam and hot water are used for washing and sterilizing, the change to an electric driven brush does not eliminate the boiler, though it will make it unnecessary to carry more than 10 or 15 pounds pressure, which will reduce the fuel cost considerably. It is also a step toward the elimination of the boiler method. 2.2 kwh. is regularly used each month for this operation.

Dairy Cooling Rooms. Like the household refrigerator the dairy cooling room, chilled by electric refrigeration machines, has been pronounced practical and successful by the three dairymen who are using them. The plan used in the experiment was intended primarily for retail dairymen who handle bottled milk, but has since been tried by several farmers handling milk in cans. Tank type coolers have been developed by other experiments for handling wholesale milk or milk in cans.

The mechanical equipment for these rooms consists of a twin cylinder, air-cooled compressor driven by a ¼ or 1-3 h. p. motor connected by pipe lines and suitable valves with a system of coils immersed in a brine tank located inside the cooling room. The units used have been found particularly efficient and ruggedly constructed as is evident from a comparison of their size and the size of room which they are chilling. One of these machines has been operating for three years, and the other two for one year.

Farm No. 1. This room measures 4½x7 ft. x 6 ft. high. The walls and ceiling have two air spaces, 3″ of cork insulation, and ½″ cement lining. During the past season an uninsulated, concrete floor was used. The room, converted from an ice cooler, is in the basement and stores 300 quarts of milk daily.

Farm No. 2. This cooler measures about 4¼x5½ ft. x 6½ ft. high, and was converted from an ice cooled storage by the addition of cork insulation varying in thickness from 1 to 3 inches. Due to irregular construction, a uniform thickness could not be applied. This room is exposed to the sun's heat for about four hours daily on two sides, and is on the same level as the barn floor. Three hundred quarts of milk are stored daily.

TABLE 19. Dairy Cooling Room Records on Experimental Farms

Farm Number	Quarts Stored	30 Day Periods Approximately Kilowatt Hours			Extent of Record
		Minimum	Maximum	Average 8 Months	
1	300	0	226	96.5	April to December '26
2	300	0	164	112	August '25 to December '26
4	300	0	175	148	April to December '26
Average	300	0	188	119	

Farm No. 4. This is a newly constructed room, containing 4″ of cork insulation in all walls, ceiling and floor, and fitted with a standard refrigerator door. The dimensions are 5¼ ft. square x 6½ ft. high. A ½″ cement lining makes it possible to sluice the room down with water in cleaning. It is on the ground floor and protected on all sides from excessive changes in temperature. A small section of the space is used by the housewife in place of a household refrigerator. For this reason the room is somewhat larger than would ordinarily be necessary. Three hundred quarts of milk are stored daily.

Records are given in Table 19.

Proper construction, using cork insulation, is essential, and location of the room in a cool, dry place will reduce operating costs. A well constructed room will provide safe storage for milk in winter by keeping out the cold as well as in summer by keeping in the cold.

Operating costs are found to compare very favorably with the older method. The maximum shown in the table occurs in August and September. During the cold months the machines are not used.

Electric Fan in the Dairy Room. An ordinary cooling fan has been used to advantage on one farm to keep away flies in the process of bottling and also to insure an abundance of fresh air. The fan is located so that the air draft is directed into the reservoir which holds the milk.

Hay Hoisting. Two tests of hay hoist equipment were made during the summer. The equipment used in both cases was identical, being a double-drum hoist, operating a lift and return rope, respectively. A 5 h. p. portable motor was used as power. The results obtained on Farm No. 1 were not satisfactory, due to the fact that the equipment was not adapted to the local conditions.

On Farm No. 6 it was found that the motor, hoist, fork and carrier were all within easy sight of the operator, making it possible to operate the hoist from the load by means of ropes. This arrangement reduced the man labor and power to a minimum, and quite successful operation was obtained.

Fifty tons (estimated) of hay, oats and millet were unloaded by this method during the 1926 season. No other method was used. The time required to unload varied from 20 to 35 minutes. Three men and a 2-horse team were used.

A test made on Japanese millet, to obtain a high demand and current consumption, showed that 1 kwh. was required per load, or .66 kwh. per ton, (estimated). This millet, having been frosted, could not be thoroughly cured and was, therefore, very rank and heavy. The maximum demand indicated that 3 h. p. should be sufficient for these conditions.

The type of hoist used should be modified and altered somewhat in design to be entirely satisfactory

Silo Filling. A considerable number of attempts have been made in New England during the past few years to operate ensilage cutters with electric motors, and the interest in this power for the work continues.

A test made on one of the dairy farms in the fall of 1926, using a 7½ H. P. motor, 11-inch cutter and elevating 36½ ft., failed to give results satisfactory to the farmer. The equipment was overhauled before the test, but no attempt was made to make local circumstances better than fair average field conditions.

A survey was made of ten practical applications in five states where motors from 5 to 20 H. P. were used for this work. Most of the operators were interviewed personally. Where conditions were representative of the average farm, 10 H. P. was the minimum that could be depended on to give satisfaction.

This does not mean that this is the final conclusion for ensilage cutting with motors; for a method developed at the University of Wisconsin holds promise of permitting the use of considerably less power, but until this method is known and accepted as practical and better than the present practice, it seems best to recommend, in a general way, not less than 10 H. P. in cases where this type of power is considered. A test of the new method is planned in the coming season.

POULTRY EQUIPMENT

Electric Incubators. Two tests were conducted at the University poultry plant during April and May, 1926. A 360-egg incubator, 8 years old but in fairly good condition, was used. This was converted from hot air to electric heat by installing a heating unit and thermostat. Only one of the two trays in the machine was used.

In one test, out of 160 eggs set, a 79.3% hatch or 127 chicks was obtained. Sixty-one kilowatt hours of current were used. The current was cut off several times, 3¾ hours being the longest interruption.

In the other test from 146 eggs set, 132 chicks, or a 90.4% hatch, was secured. Fifty-eight kilowatt hours of current were used. No current interruptions occurred.

The quality and vitality of chicks appeared to be excellent and above the average for chicks from the same hens hatched by other means, according to experienced observers.

Successful operation of electric incubators is reported by many users, and several different types of equipment are now available which have not been tested.

In well insulated machines the current may be cut off for several hours without material damage.

It appears to be possible to obtain a better percent of hatch and quality of chick from some electric incubators.

Further experimental work is desirable.

Electric Brooders. Brooding chicks by electricity, on the basis of the usual methods common to poultrymen in this section, has not been found practical up to this time. The cold temperatures prevailing in New England during the brooding season make it impossible for an electric brooder, operating in an unheated brooder house, to give sufficient protection to young chicks.

The brooding of chicks in buildings warmed by a central heating plant, however, is rapidly gaining favor among poultrymen, and under such conditions successful operation of electric brooders can be safely predicted.

Several reports have appeared to the effect that the New Hampshire project "has been entirely successful in brooding by electricity." This has arisen from a lack of distinction between preliminary tests of some of the elements of brooders and the brooding of chickens considered as a complete problem. No satisfactory solution of the whole problem has been obtained and it is recommended for the present that electric brooders, if used at all in this climate, be operated only in well heated rooms.

Considerable further research in this field is believed desirable.

Grain and Feed Mixer. Construction of a grain and feed mixer of 1500 pounds capacity which will successfully mix any kind of cracked grain or mash feeds, has recently been completed in cooperation with a manufacturer of grain mixing machinery. Any number of ingredients can be placed in the machine, and the product delivered to nearby storage bins. The equipment will also thoroughly mix cod liver oil or molasses with mash feeds without lumping. One horsepower will probably be sufficient to operate it. Operating costs are not at present available, but these are expected to be very reasonable.

This equipment, which should be equally practical for dairy farms, will permit farmers to buy purer grain ingredients and mix rations of higher feeding value at less total cost under present grain buying conditions. Many farmers have been interested in this plan but have not adopted the practice because of the lack of a suitable, time-saving mixing device.

Ultra-Violet Light. To obtain the comparative value of cod liver oil and ultra-violet light, four test pens of baby chicks are being used. Each pen contains about 600 chicks, is 14 ft. x 20 ft. giving 66 sq. ins. or .46 sq. ft. per chick, is well lighted through window glass, and heated by a coal brooder. The chicks are on wood floors. One pen is used as a check without cod liver oil or ultra-violet light; in another, cod liver oil alone is used; in another both cod liver oil and ultra-violet light; while the last pen has ultra-violet light alone. The test will be run several times or until definite results are obtained. The lamp which consumes .6 kw. per hour is 4½ ft. from the floor and is left on for 45 minutes each day.

Tests are also planned on the effect of exposing feed to ultra-violet light, on its usefulness in the prevention of disease, and on its effect when used on laying hens, on the hatchability of eggs and the vigor of the chicks.

Poultry Lighting. Using electric lights in pens of laying hens to prolong the daylight conditions one hour morning and night is generally accepted as a practical and profitable process among poultry men in New England. The picturesque sight of lighted poultry houses at dusk is not uncommon. The current consumption will vary with the number of lamps used and methods employed. Farm No. 6 used very little poultry lighting during the two years due to certain unusual conditions. Farm No. 7, however, showed a more normal use of these lights, the current consumption for which started at zero in late October and reached a maximum of 157 in January.

Oats Sprouter. A year around operation on many poultry farms is the germination of oats to supply green feed to the young stock.

A roughly built sprouter, not insulated, has been in operation in a cool basement of the University poultry plant during the past year. The inside dimensions are 32″ deep, 54″ wide and 72″ high. Twenty pans 23″ square and 2″ deep, arranged in two vertical tiers, hold 20 lbs. of moist oats (10 lbs. dry, soaked 24 hrs.) each, and produce 24 to 28 quarts of germinated oats.

Two 220-watt electric space heaters produced sufficient heat for the mildly cool weather of fall and spring but not enough for winter operation. It is

estimated that about 880 watts will be necessary for the coldest weather. Using 440 watts the current consumption amounts to 5.28 kwhs. per day or 158.4 per month. These values would be doubled with heaters totaling 880 watts. The operating characteristics were excellent.

OPPORTUNITIES FOR FURTHER RESEARCH

The opportunities for further research, especially in the field of farmstead operations, seem at times to be almost unlimited. Some farmers are doing experimental work of their own in the uses of electricity.

Some of the problems that have been suggested and appear to offer possibilities of successful applications of electricity are given below. In addition, there is the further development of some of the equipment already mentioned and the maintaining of experiments already under way.

Fruit Equipment.

A motor-driven cider press, suitable for use in disposing of culls and poor grade fruit in the form of cider or vinegar, will be tested during the next season.

Spraying or dusting machinery is now powered by gas engines, and an opportunity exists for using electric motors, if a practical method of supplying current can be developed. A new method, using a stationary spray plant, as developed by the Washington project, is reported to have met with considerable approval.

Insect Trapping. The fact that moths and insects will gather around a light has suggested to one of our fruit farmers that injurious pests could be trapped in pans of oil suspended under lights placed at intervals in the orchard. The results obtained from first trials of this system on tomatoes in the Virginia project indicate possibilities. This and work on spraying and dusting equipment could be combined as far as the field wiring is concerned.

Dairy Equipment.

Stock Clippers. Dairymen have learned that clean milk is much more easily produced when the flanks and udders of cows are kept clean. Keeping the hair on these parts clipped short is desirable, and requests for practical, inexpensive clippers have been received. Tests are planned using modified barber clippers, standard stock clippers and hand-operated clippers converted to motor drive.

Milk Cooling. Several methods of removing body heat from milk are possible besides that of using cold well or spring water. Various ways of using electric refrigeration equipment offer promising possibilities, and many inquiries indicate considerable interest.

Sterilized utensils are essential to the production of high grade, clean milk. Methods now used are not always adequate to cope with the situation. Electric equipment which can probably be adapted to this work has been located. This is a mid-day operation with dairy farms, and occurs every day of the year.

Sterilization of Milk. Pasteurized milk is sometimes said to be lacking in natural quality or taste, but the ever increasing strictness of regulations governing the milk produced for market raises the problem of how else milk may be sterilized. Several possible methods have been suggested for doing this electrically.

Cold Storage for Wholesale Milk. Wholesale milk is usually handled in 40 quart cans, and smaller cold storage rooms of a somewhat different type than the cooling rooms already described may be used. Dry storage is also desirable and a plan is suggested for using the electric refrigeration machine for this purpose.

Fertilizer Mixing. Home-mixed commercial fertilizers are often higher in plant food value and cost less than when purchased ready mixed. Developing a convenient method for this operation has been suggested.

Paint spray equipment may have several uses about a farm of any type. The painting of farm buildings alone is an item of considerable expense, mostly labor, and there are several other uses to which this equipment could be put. Tests on the use of this equipment are planned.

Poultry Equipment.

Flat, pancake-type *poultry fountain heaters* for keeping water from freezing in poultry buildings have been given preliminary tests which indicate that they are feasible, but details on their capacity and cost of operation are not yet available.

Poultry Pen Cleaning Equipment. Certain poultry diseases, which have recently developed, require the cleaning of houses or pens at very frequent intervals as a control. To do this once every three days entails a very considerable cost for labor. A plan for doing most of this work with electricity as power has been developed, and it is planned to test out the equipment on one of the poultry farms.

Yard and Building Searchlight. Safeguarding property at night and inspecting buildings and grounds for prowlers and other disturbances is thought practical by the use of a searchlight. Such a device is at hand ready to be installed.

Brooding and Incubation. It seems of considerable importance that further studies in brooding and incubation equipment should be made.

SUMMARY

Seven farms in New Hampshire, representing dairy, poultry, fruit and general farms, were selected in the spring of 1925 and equipped with appliances to determine what limits in quantity of electricity can be economically used and to secure data on the efficiency of the different appliances. The farms were chosen as typical of substantial and successful enterprises operated with modern, well balanced methods.

Sixty major and 40 minor pieces of electrical equipment are now in use on these farms covering 36 distinct operations, and metered in such a way that detailed records can be secured each month for nearly every appliance.

This bulletin presents figures for the period ending December 31, 1926, including inventories, current consumption and costs for each circuit by farms, and current consumption by appliances.

Current consumption on the seven farms averaged 1683 kilowatt hours for the year 1925 and increased to 4253 kilowatt hours in 1926.

Heating equipment, such as refrigeration, ranges, ironers, water heaters, etc., produced the greatest effect on the total consumption and developed a peak load in midsummer.

Total consumption for the year 1926 was distributed as follows: winter, 23%; spring, 16%; summer, 32%; and fall, 28%.

Total consumption by farms for 1926 ranged from 432 kilowatt hours for the fruit farm to 7694 kilowatt hours for one of the dairy farms.

The records are still too limited to draw many detailed conclusions, and further research, particularly with farmstead appliances, is desirable.

House lights showed an average monthly consumption of 34.6 kilowatt hours, ranging from 15.2 to 63.3.

Water pumps showed an average monthly consumption of 23.7 kilowatt hours, ranging from 3.7 to 39.

Kitchen ranges showed an average monthly consumption of 167 kilowatt hours, ranging from 26 to 282. Combination ranges with wood and coal and straight electric ranges are being used.

House refrigerators used an average of 35.3 kilowatt hours per month, ranging from 23 to 39.5.

Hot water heaters used an average of 182 kilowatt hours per month, ranging from 15.2 to 548. They have given a high degree of service, but their cost of operation has been high.

Washing machines used an average of 2.6 kilowatt hours per month.

Flatirons used an average of 7.3 kilowatt hours per month, and ironing machines 12.7.

Barn lights used an average of 7.9 kilowatt hours per month, ranging from 4.3 to 13.9.

Milking machines used an average of 91.5 kilowatt hours per month, ranging from 56.5 to 134.

Dairy cooling rooms showed an average monthly consumption of 119 kilowatt hours, ranging from 96.5 to 148.

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